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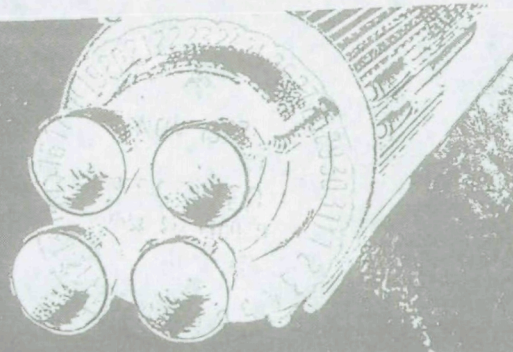

OPTICS-INERTIAL TEST SET

CHECKOUT, MAINTENANCE, AND REPAIR MANUAL

C/M SYSTEM

THE ELECTRONICS DIVISION OF GENERAL MOTORS CORPORATION

SPARK PLUG

1 JANUARY 1964

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TYPE I PRELIMINARY
NASA APPROVAL PENDING

APOLLO

OPTICS-INERTIAL TEST SET

CHECKOUT, MAINTENANCE, AND REPAIR MANUAL

C/M SYSTEM

PREPARED FOR

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER

BY
AC SPARK PLUG
THE ELECTRONICS DIVISION OF
GENERAL MOTORS CORPORATION
MILWAUKEE 1, WISCONSIN

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NOTE: Refer to Appendix A
for list of JDC's which are
part of this manual.

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LIST OF RELATED MANUALS

ND 1021000	AGC Test Set Checkout, Maintenance, and Repair Manual
ND 1021001	Computer Subsystem Checkout, Maintenance, and Repair Manual
ND 1021002	AGC Calibration System Checkout, Maintenance, and Repair Manual
ND 1021003	AGC Simulator Checkout, Maintenance, and Repair Manual
ND 1021034	Associated Test Equipment Checkout, Maintenance, and Repair Manual
ND 1021036	Guidance and Navigation System Checkout, Maintenance, and Repair Manual
ND 1021066	Miscellaneous Optical Subsystem Test Equipment Checkout, Maintenance, and Repair Manual
ND 1021067	Optical Unit Checkout, Maintenance, and Repair Manual
ND 1021068	Functional Tester Checkout, Maintenance, and Repair Manual
ND 1021069	Map and Data Viewer, Checkout, Maintenance, and Repair Manual
ND 1021070	Precision Test Fixture Checkout, Maintenance, and Repair Manual
ND 1021071	Map and Data Viewer Tester Checkout, Maintenance, and Repair Manual

Chapter 1

DESCRIPTION AND LEADING PARTICULARS

1-1 INTRODUCTION

1-1.1 SCOPE AND PURPOSE OF MANUAL. This manual contains the information necessary to maintain the optics-inertial test set, part number 1900005, at field sites. This information includes physical description, theory of operation, a list of support equipment, and job description cards (JDC's) containing procedures for packaging, checking out, and calibrating the optics-inertial test set. Data available as of 15 December 1963 was used in preparation of this manual. Information becoming available after this date will be included in subsequent issues of the manual.

This manual provides detailed information only for those components of the optics-inertial test set manufactured by AC Spark Plug. Separate publications for commercial and special components of the optics-inertial test set are provided at the field sites.

This manual is to be used by contractor personnel at all field sites.

1-1.2 PURPOSE OF EQUIPMENT. The optics-inertial test set is used at field and contractor sites in checking out the optical and inertial subsystems (OSS and ISS) of the guidance and navigation (G and N) system used in the Apollo command module. It is also used to check out the complete G and N system. The functions of the individual components of the optics-inertial test set are given in table 1-I.

1-2 PHYSICAL DESCRIPTION

The optics-inertial test set is illustrated in figure 1-1. The physical characteristics of the AC Spark Plug manufactured components of the optics-inertial test set are listed in table 1-II.

1-3 LOCATION AND FUNCTION OF CONTROLS AND INDICATORS

Figures 1-2 through 1-14 illustrate the front panels of the AC Spark Plug manufactured panels in the optics-inertial test set. The legends for these figures include explanations of the panel control and indicator functions. Detailed explanations of the function of the multiple-position, signal selection switches in these panels are provided in the following paragraphs.

Table 1-I. Functions of Optics-Inertial Test Set Components

Component	Part Number	Function
Optics-Inertial Analyzer	1900004-011	
Monitor panel	1900055-011	Indicates malfunctions that occur in airborne equipment and optics-inertial test set.
Temperature monitor and control panel	1900058-011	Controls and monitors temperature of inertial components in IMU and calibrates airborne temperature control circuits.
Power supply and load panel	1900702-011	Provides simulated loads for airborne circuits; supplies airborne lamp power and ducosyn excitation.
Monitor oscilloscopes	1900038-011	Continuously monitor 25 IRIG and 16 PIP preamp outputs.
Gimbal position control panel	1900054-011	Positions IMU gimbals.
Test control panel	1900059-011	Controls power applied to optics-inertial analyzer and to airborne equipment; selects normal functional modes of airborne equipment and optics-inertial test set.
Test selector panel	1900082-011	Selects test to be performed on airborne equipment.
Phase shift panel	1900163-011	Provides variable phase shift for reference signals applied to the monitor oscilloscopes.
Digital recorder panel	1900052-011	Records, in digital form, signals monitored by the digital voltmeter, the counter, and the Apollo guidance computer test set.
Electronics power supply	1900035-011	Provides +30 and -30 volts dc for optics-inertial analyzer.

(cont)

Table 1-I. Functions of Optics-Inertial Test Set Components (cont)

Component	Part Number	Function
Optics-Inertial Analyzer (cont)		
Dual beam oscilloscope	1900037-011	Provides visual monitoring of airborne signals other than 25 IRIG and 16 PIP outputs.
Primary signal selector panel	1900057-011	Routes airborne signals to counter, digital voltmeter, dual beam oscilloscope, and phase angle voltmeter; controls position of crossbar switch.
Coaxial distribution panel	1900166-011	Provides switching, by means of coaxial jumpers, for airborne signals which cannot be fed through switches; sends signals to dual beam oscilloscope.
Crossbar switch	1900048-011	Selects signals sent to primary signal selector panel; controlled by switch in primary signal selector panel.
Digital voltmeter	1900042-011	Measures output of airborne ac and dc power supplies and other signals.
Phase angle voltmeter	1900036-011	Measures phase angle of airborne signals; measures in-phase components of airborne signals.
Counter	1900041-011	Monitors pulse outputs of airborne equipment and optics-inertial analyzer.
Oscillograph signal selector panel	1900056-011	Selects signals sent to the oscillograph console.
Signal generator	1900043-011	Supplies inputs to ISS stabilization loops.

(cont)

Table 1-I, Functions of Optics-Inertial Test Set Components (cont)

Component	Part Number	Function
Optics-Inertial Analyzer (cont)		
Relay and lamp power supply	1900049-011	Supplies 28 volts dc to operate relays and lamps in optics-inertial test set.
AC power protection panel	1900075-011	Controls application of power to optics-inertial analyzer.
Oscillograph console	1900000-011	
Remote counter indicator	1900039-011	Provides duplicate readout of counter in optics-inertial analyzer.
Oscillograph amplifier assemblies (two)	1900044-011 and 1900045-011	Amplifies signals to be applied to the oscillograph.
Oscillograph electric pen control panel	1900164-011	Provides power for electric pens used in oscillograph.
Oscillograph control panel	1900046-011	Applies power to oscillograph console; controls all functions of oscillograph.
Oscillograph	1900047-011	Makes permanent record of signals applied.
Coolant and power console	1900145-011	
Current source monitor panel	1900053-011	Monitors precision voltage reference modules in PSA.
Galvanometer	1900034-011	Acts as null detector for current source monitor panel.

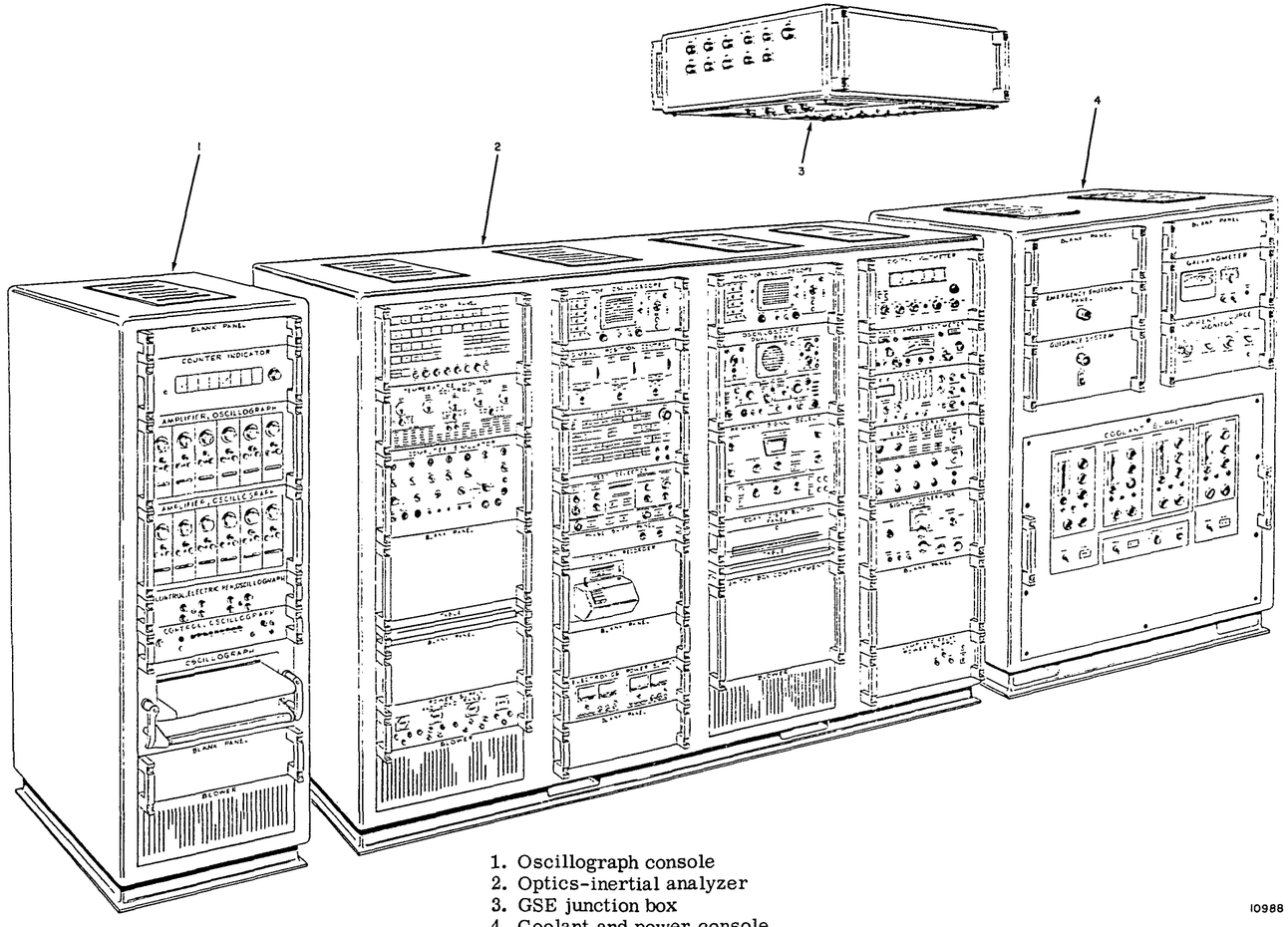
(cont)

Table 1-I. Functions of Optics-Inertial Test Set Components (cont)

Component	Part Number	Function
Coolant and power console (cont)		
Guidance system power supply	1900033-011	Supplies 28 volts dc prime power for airborne equipment.
Coolant supply and distribution panel	1900098-011	Provides and circulates coolant solution through airborne equipment.
GSE junction box	1900433-011	Provides interconnection between airborne equipment and optics-inertial test set.
PSA test point adapter	1900931-011	Bypasses GSE junction box with certain signals to optics-inertial analyzer and coolant and power console.

Table 1-II. Physical Characteristics of Optics-Inertial Test Set

Item	Estimated weight in pounds	Approx. dimensions in inches		
		Height	Width	Depth
Optics-inertial analyzer		79	30	96
Monitor panel	55	10-1/2	19	20
Temperature monitor and control panel	47	12-1/4	19	21
Power supply and load panel	40	7	19	20-1/2
Gimbal position control panel	50	8-3/4	19	21-1/2
Test control panel	50	8-3/4	19	20-1/2
Test selector panel	60	10-1/2	19	20-1/2
Phase shift panel		3-1/2	19	7
Primary signal selector panel		14	19	20-1/2
Coaxial distribution panel	10	5-1/4	19	8-7/8
Oscillograph signal selector panel		12-1/4	19	20-1/2
AC power protection panel	35	8-3/4	20-1/2	7-1/2
Oscillograph console		79	30	24
Coolant and power console		79	30	48
Current source monitor panel	60	8-3/4	19	18-1/2
GSE junction box	125	18-1/2	33-5/8	36-1/4
PSA test point adapter assembly				



1. Oscillograph console
2. Optics-inertial analyzer
3. GSE junction box
4. Coolant and power console

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Figure 1-1. Optics-Inertial Test Set

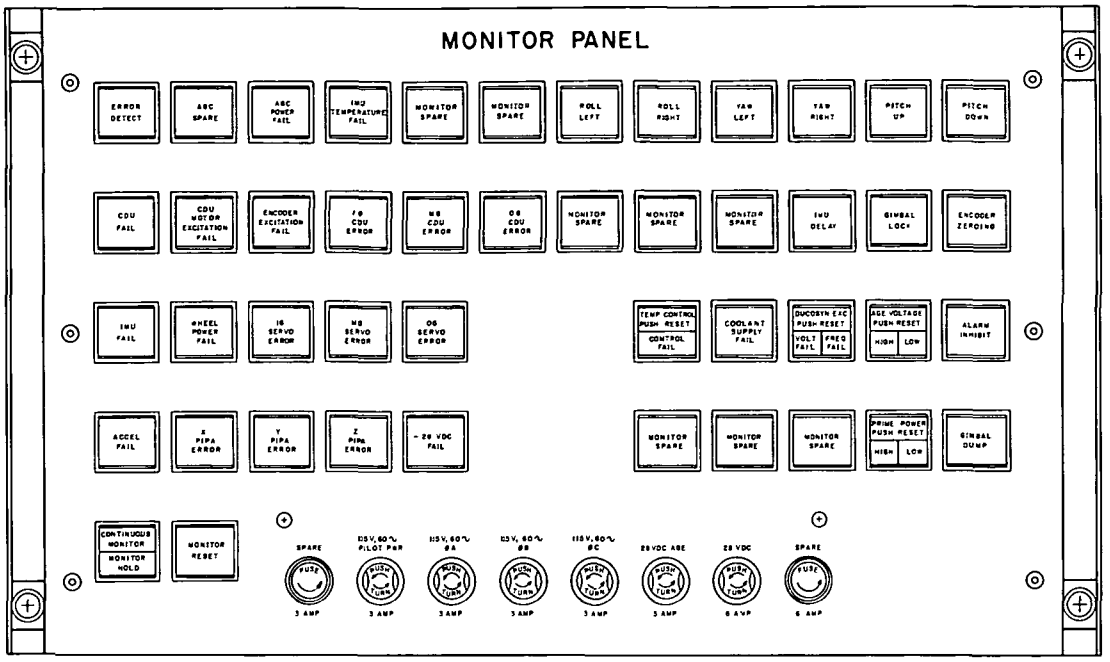
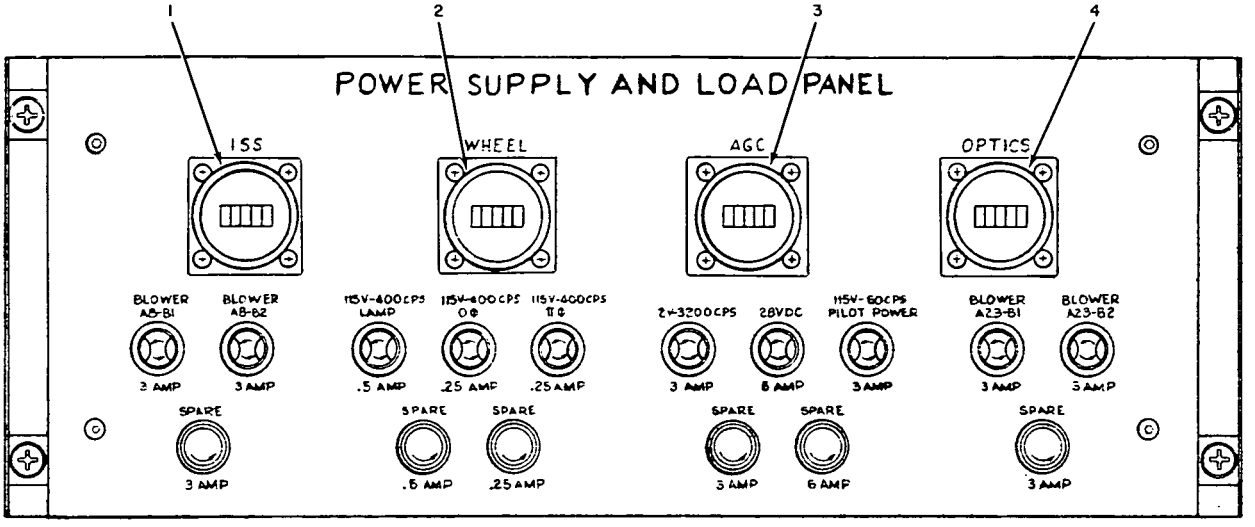


Figure 1-2. Monitor Panel

(To be supplied)

Figure 1-3. Temperature Monitor and Control Panel



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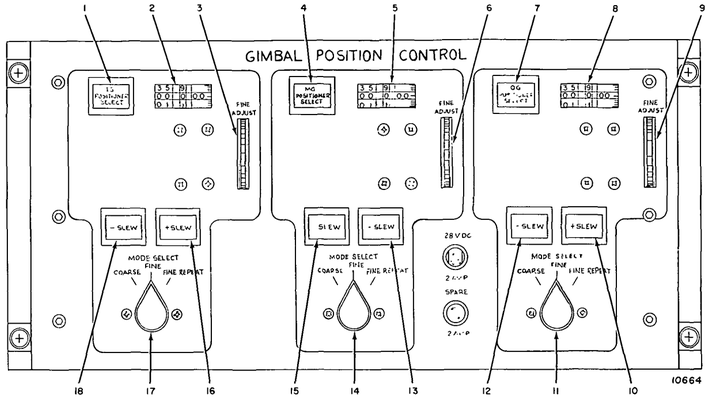
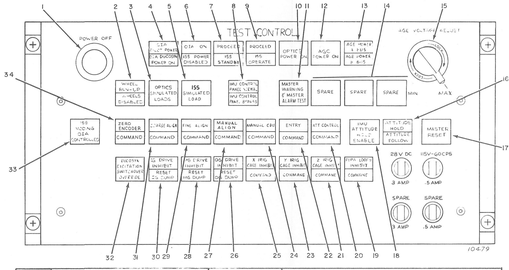
Index No.	Name	Reference Designation	Function
1	ISS elapsed time indicator	M4	Indicates how long inertial subsystem has been energized while connected to optics-inertial test set.
2	WHEEL elapsed time indicator	M3	Indicates how long gyro wheel power has been applied while IMU was connected to optics-inertial test set.
3	AGC elapsed time indicator	M2	Indicates how long Apollo Guidance Computer (AGC) has been energized while connected to optics-inertial test set.
4	OPTICS elapsed time indicator	M1	Indicates time optics subsystem has been energized while connected to optics-inertial test set.

Figure 1-4. Power Supply and Load Panel



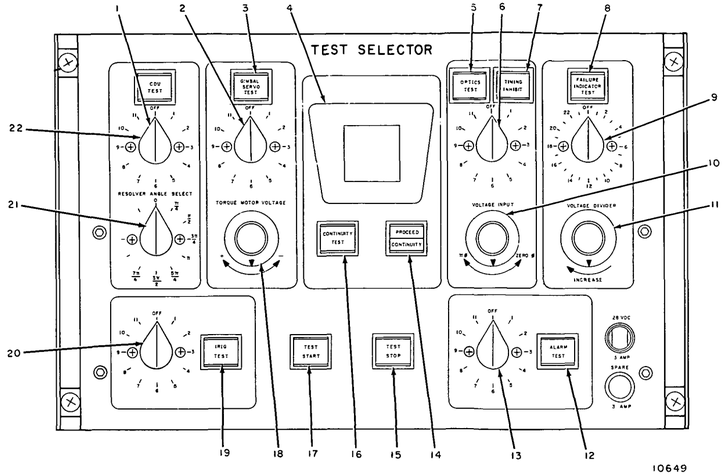
Index No.	Name	Reference Designation	Function
1	IG POSITIONER SELECT switch	S1	Switches control of inner gimbal position to gimbal position control panel.
2	Inner gimbal position display	-	Displays inner gimbal position set into gimbal position control panel.
3	Inner gimbal FINE ADJUST control	-	Provides vernier adjustment of inner gimbal position.
4	MG POSITIONER SELECT switch	S2	Switches control of middle gimbal position to gimbal position control panel.
5	Middle gimbal position display	-	Displays middle gimbal position set into gimbal position control panel.
6	Middle gimbal FINE ADJUST control	-	Provides vernier adjustment of middle gimbal position.
7	OG POSITIONER SELECT switch	S3	Switches control of outer gimbal position to gimbal position control panel.
8	Outer gimbal position display	-	Displays outer gimbal position set into gimbal position control panel.
9	Outer gimbal FINE ADJUST control	-	Provides vernier adjustment of outer gimbal position.
10	Outer gimbal +SLEW switch	S9	Slews outer gimbal in positive direction.
11	Outer gimbal MODE SELECT switch	S12	Selects mode of operation for outer gimbal control circuit.
12	Outer gimbal -SLEW switch	S8	Slews outer gimbal in negative direction.
13	Middle gimbal +SLEW switch	S7	Slews middle gimbal in positive direction.
14	Middle gimbal MODE SELECT switch	S11	Selects mode of operation for middle gimbal control circuit.
15	Middle gimbal -SLEW switch	S6	Slews middle gimbal in negative direction.
16	Inner gimbal +SLEW switch	S5	Slews inner gimbal in positive direction.
17	Inner gimbal MODE SELECT switch	S10	Selects mode of operation for inner gimbal control circuit.
18	Inner gimbal -SLEW switch	S4	Slews inner gimbal in negative direction.

Figure 1-5. Gimbal Position Control Panel



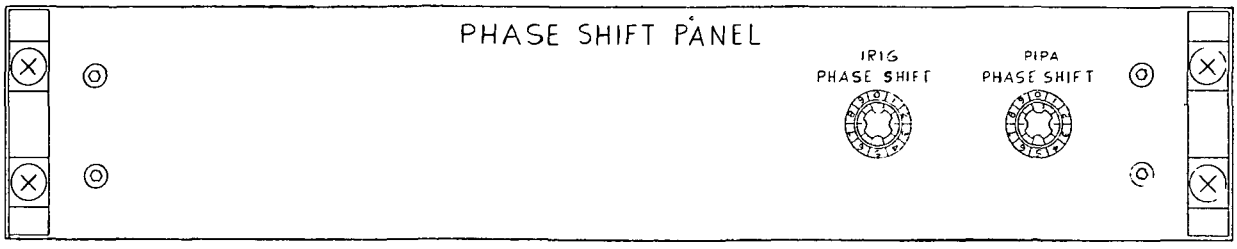
Index No.	Name	Reference Designation	Function
1	POWER OFF switch	S1	Removes all power except pilot power from optics-inertial analyzer.
2	WHEEL RUN-UP/WHEELS DISABLED switch	S7	Controls power to gyro wheels.
3	OPTICS SIMULATED LOADS switch	S8	Switches optics subsystem power supplies to simulated loads.
4	OIA PILOT POWER/OIA DUCOSYN POWER ON lamp	DS1	Lights to indicate pilot power and ducosyn power from optics-inertial analyzer are present.
5	ISS SIMULATED LOADS switch	S9	Switches inertial subsystem power supplies to simulated loads.
6	OIA ON/ISS POWER DISABLED switch	S2	Applies power to optics-inertial analyzer.
7	PROCEED/ISS STANDBY switch	S3	Switches inertial subsystem to standby mode of operation.
8	IMU CONTROL PANEL NORMAL/IMU CONTROL PANEL BYPASS switch	S10	Switches control of IMU from IMU control panel to test control panel.
9	PROCEED/ISS OPERATE switch	S4	Switches inertial subsystem to operational condition.
10	OPTICS POWER ON switch	S5	Applies power to optical subsystem.
11	MASTER WARNING & MASTER ALARM TEST switch	S11	Provides simulated interface signal from command module systems other than the G and N system.
12	AGC POWER ON switch	S6	Applies power to AGC.
13	AGE POWER A BUS/ AGE POWER B BUS switch	S34	Selects PSA power input bus to which power from optics inertial analyzer is applied.
14	SPARE	S12, S13, S14	Provides spare switch capability.
15	AGE VOLTAGE ADJUST control	R1	Adjusts output of 28-volt dc power supply in coolant and power console.
16	ATTITUDE HOLD/ ATTITUDE FOLLOW switch	S24	Simulates function of ATTITUDE HOLD/ATTITUDE FOLLOW switch on main display and control panel.
17	MASTER RESET switch	S25	Resets all optics-inertial analyzer functions to predetermined condition.
18	IMU ATTITUDE HOLD ENABLE switch	S23	Simulates function of IMU ATTITUDE HOLD ENABLE switch on main display and control panel.
19	PIPA LOOPS INHIBIT/ COMMAND switch	S33	Removes 28 volts dc from PIPA loop electronics.
20	ATT CONTROL/ COMMAND switch	S22	Simulates function of ATT CONTROL/ COMMAND switch on IMU control panel.
21	Z IRIG CAGE INHIBIT/ COMMAND switch	S32	Removes Z IRIG preamplifier signal from interrogater.
22	ENTRY/COMMAND switch	S21	Simulates function of ENTRY/ COMMAND switch on IMU control panel.
23	Y IRIG CAGE INHIBIT/ COMMAND switch	S31	Removes Y IRIG preamplifier signal from interrogator.
24	MANUAL CDU/COMMAND switch	S20	Simulates function of MANUAL CDU/ COMMAND switch on IMU control panel.
25	X IRIG CAGE INHIBIT/ COMMAND switch	S30	Removes X IRIG preamplifier signal from interrogator.
26	OG DRIVE INHIBIT/ RESET OG DUMP switch	S29	Removes outer gimbal torque motor input.
27	MANUAL ALIGN/ COMMAND switch	S19	Simulates function of MANUAL ALIGN/COMMAND switch on IMU control panel
28	MG DRIVE INHIBIT/ RESET MG DUMP switch	S28	Removes middle gimbal torque motor input.
29	FINE ALIGN/COMMAND switch	S18	Simulates function of FINE ALIGN/ COMMAND switch on IMU control panel.
30	IG DRIVE INHIBIT/ RESET IG DUMP switch	S27	Removes inner gimbal torque motor input.
31	COARSE ALIGN/ COMMAND switch	S17	Simulates function of COARSE ALIGN/COMMAND switch on IMU control panel.
32	DUCOSYN EXCITATION SWITCHOVER OVERRIDE switch	S26	Prevents automatic transfer from airborne to optics-inertial analyzer ducosyn power supply.
33	ISS MODING OIA CONTROLLED lamp	DS15	Lights when simulated controls intest control panel are enabled.
34	ZERO ENCODER/ COMMAND switch	S16	Simulates function of ZERO ENCODER/COMMAND switch on IMU control panel.

Figure 1-6. Test Control Panel



Index No.	Name	Reference Designation	Function
1	CDU TEST switch	S1	Enables CDU (coupling display unit) test circuit and disables all other test circuits in this panel.
2	Gimbal test selector switch	S7	Selects gimbal to be tested and the type of test to be performed.
3	GIMBAL SERVO TEST switch	S2	Enables gimbal servo test circuit and disables all other test circuits in this panel.
4	Continuity test indicator	-	Indicates number of the continuity test being performed, as determined by position of stepping switch in GSE junction box.
5	OPTICS TEST switch	S3	Enables optics test circuit and disables all other test circuits in this panel.
6	Optics servo selector switch	S8	Selects the optics subsystem servo to be tested. Also selects the length of time that the test voltage is to be applied.
7	TIMING INHIBIT switch	S4	Overrides the time selection made by the optics servo selector so that the test voltage can be applied for an indefinite time.
8	FAILURE INDICATOR TEST switch	S5	Enables failure indicator test circuit and disables all other test circuits in this panel.
9	Failure indicator selector switch	S9	Selects airborne failure indicator circuit to be tested.
10	VOLTAGE INPUT control	R2	Controls level of test voltage applied in optics servo test.
11	VOLTAGE DIVIDER control	R3	Controls input to airborne failure indicator circuit being tested.
12	ALARM TEST switch	S18	Enables alarm test circuit and disables all other test circuits in this panel.
13	Alarm circuit selector switch	S17	Selects alarm circuit in optics-inertial test set to be tested and provides the necessary test input.
14	PROCEED/CONTINUITY switch	S12	Advances stepping switch to determine which continuity test is to be performed.
15	TEST STOP switch	S16	Stops any test being performed by this panel.
16	CONTINUITY TEST switch	S11	Enables continuity test circuits.
17	TEST START switch	S15	Initiates each test performed by this panel.
18	TORQUE MOTOR VOLTAGE control	R1	Controls test voltage applied to gimbal torque motor during friction tests.
19	IRIG TEST switch	S14	Enables IRIG test circuits and disables all other test circuits in this panel.
20	IRIG test selector switch	S13	Places inertial subsystem circuits in configurations required for performance of IRIG tests.
21	RESOLVER ANGLE SELECT switch	S10	Selects test voltage, representing an angle, to be applied to CDU under test.
22	CDU test selector switch	S6	Selects CDU to be tested and the type of test to be performed.

Figure 1-7. Test Selector Panel



Name	Reference Designation	Function
IRIG PHASE SHIFT control	R2	Provides phase shift for reference voltage applied to IRIG monitor oscilloscope.
PIPA PHASE SHIFT control	R1	Provides phase shift for reference voltage applied to PIPA monitor oscilloscope.

Figure 1-8. Phase Shift Panel

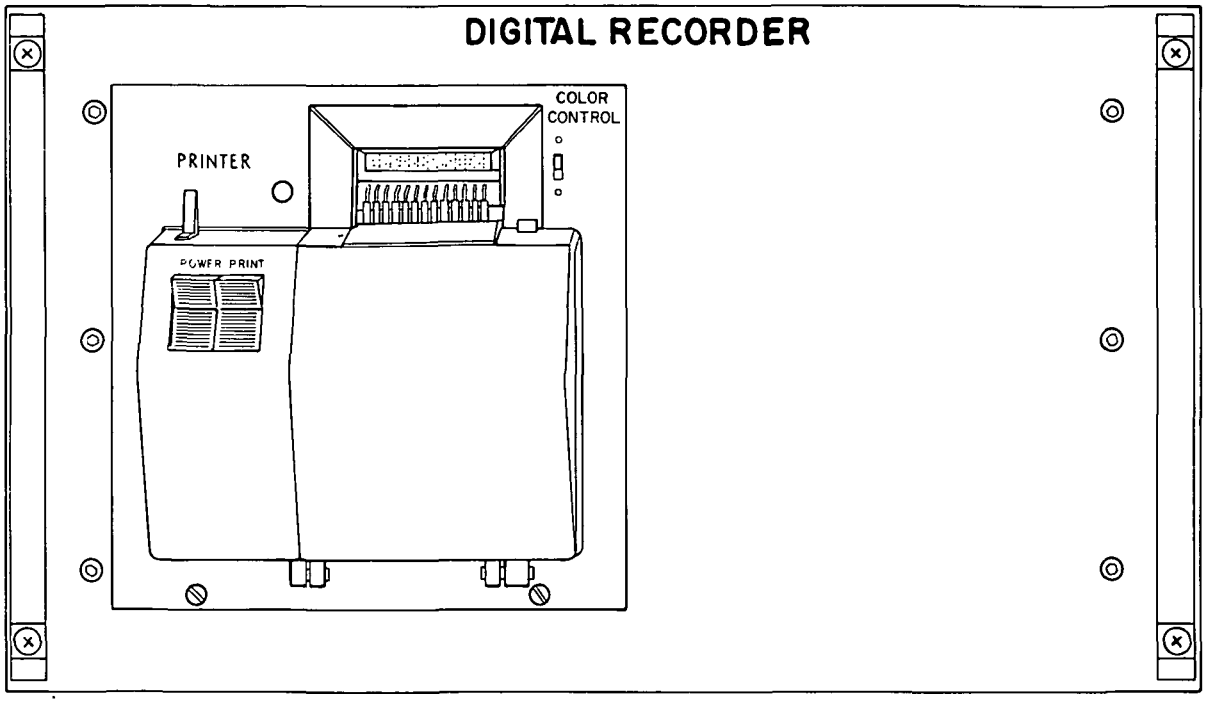
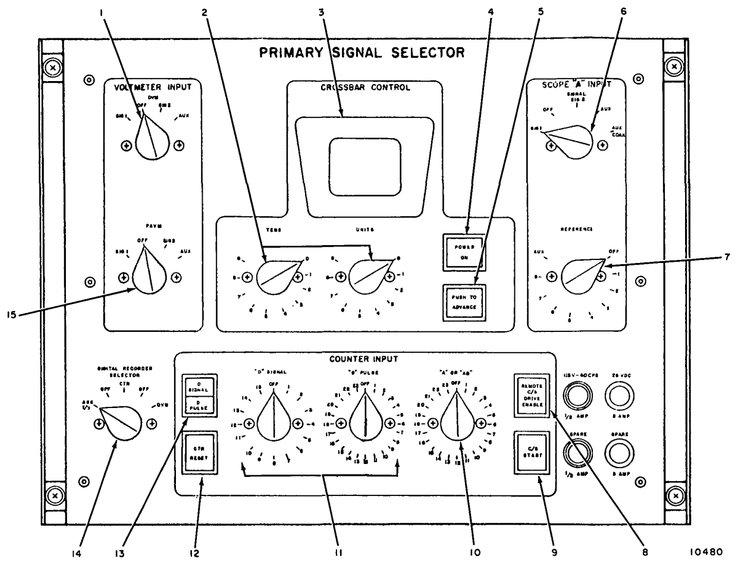
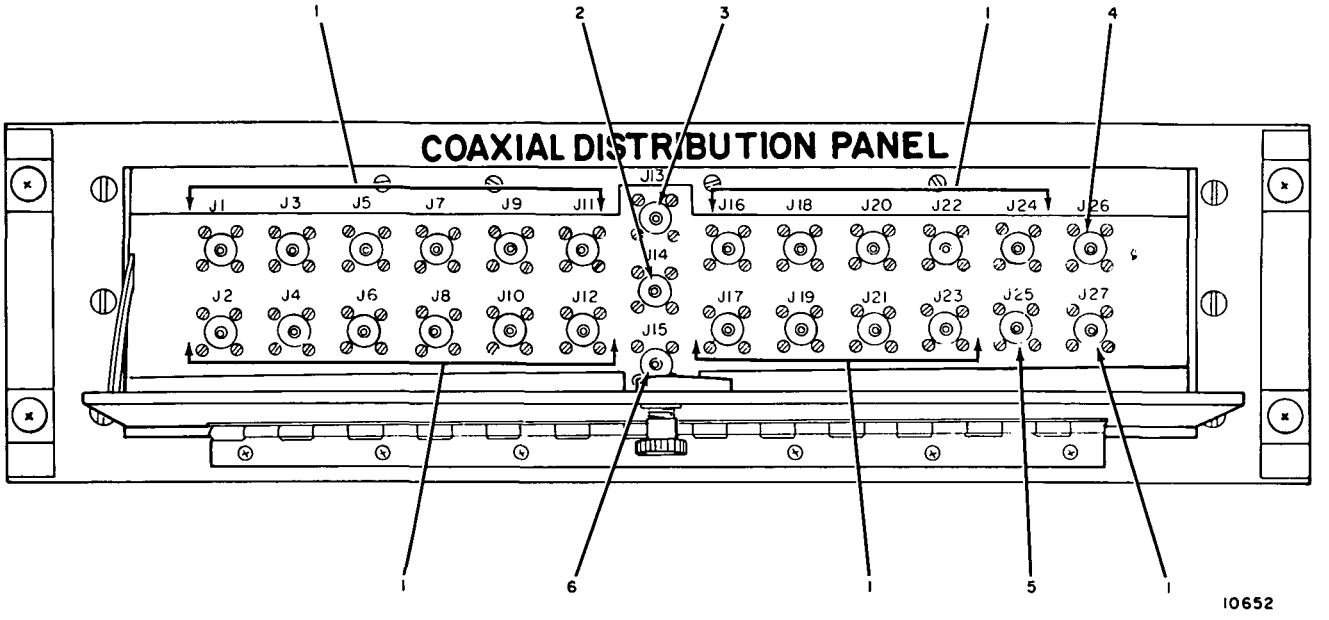


Figure 1-9. Digital Recorder Panel



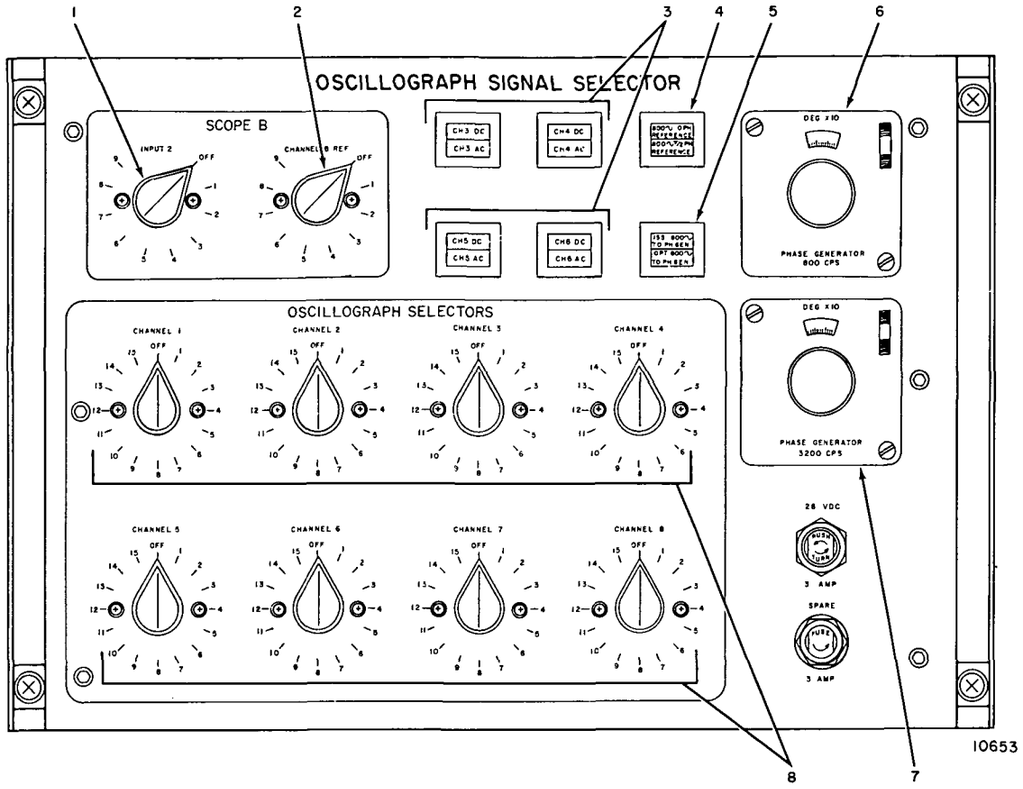
Index No.	Name	Reference Designation	Function
1	DVM switch	S2	Selects input to be monitored on digital voltmeter.
2	TENS and UNITS switches	S7, S6	Select position (00 through 99) of crossbar switch. Crossbar switch, however, will go to this position only when PUSH TO ADVANCE switch is pressed.
3	Crossbar position indicator	-	Provides readout of crossbar switch position. This readout will not necessarily agree with the position of the UNITS and TENS switches.
4	POWER ON switch	S4	Supplies power to crossbar switch control circuit.
5	PUSH TO ADVANCE switch	S5	Causes crossbar switch to move to position set in on UNITS and TENS switches.
6	SCOPE "A" INPUT SIGNAL switch	S1	Selects input to be monitored on scope A portion of dual beam oscilloscope.
7	SCOPE "A" INPUT REFERENCE switch	S3	Selects reference signal to be applied to scope A portion of dual beam oscilloscope.
8	REMOTE C/S DRIVE ENABLE switch	S9	Applies power to circuits used to start computer simulator operation.
9	C/S START switch	S12	Starts computer simulator operation.
10	"A" OR "AB" switch	A1S1	Selects signals to be monitored by counter (channels A and B).
11	"D" PULSE and "D" SIGNAL switches	A2S1, A3S1	Select signals to be used to start and stop counter operation (channel D). Whether the output of "D" PULSE switch or of "D" SIGNAL switch is sent to the counter is determined by D SIGNAL--D PULSE switch.
12	CTR RESET switch	S13	Provides manual reset control for counter.
13	D SIGNAL/D PULSE switch	S10	Selects output of either "D" PULSE or "D" SIGNAL switch to be sent to counter.
14	DIGITAL RECORDER SELECTOR	S11	Selects source of inputs recorded by digital recorder panel.
15	PAVM switch	S8	Selects input to be monitored on phase angle voltmeter.

Figure 1-10. Primary Signal Selector Panel



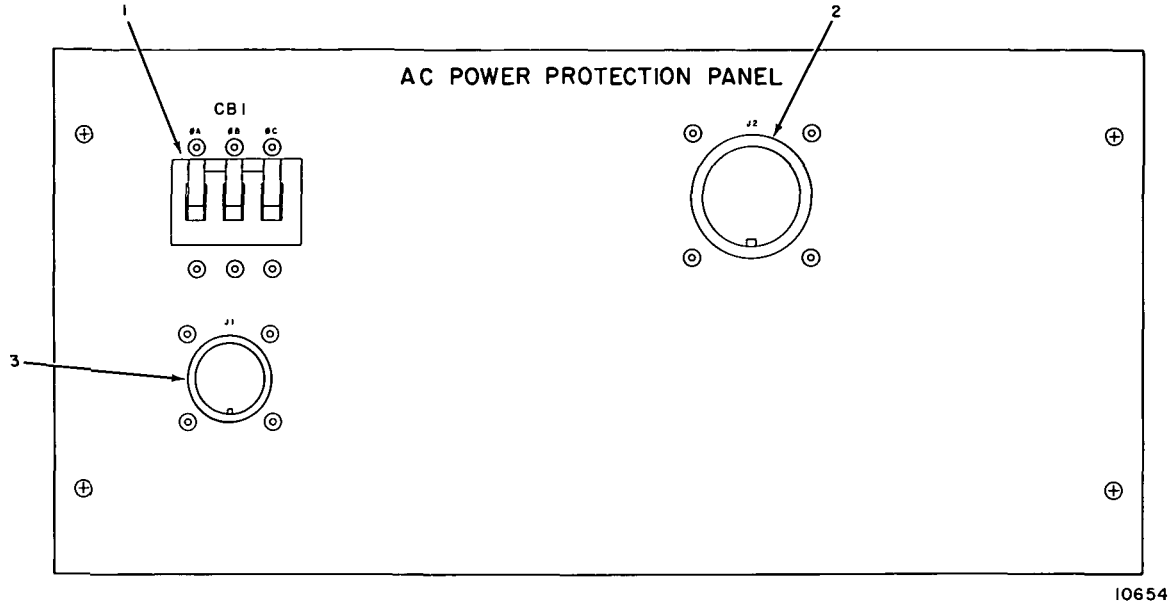
Index No.	Name	Reference Designation	Function
1	Input connectors	J1 through J12, J16 through J24, and J27	Receive critical signals from airborne equipment. They are coupled to output connectors by coaxial jumpers.
2	Output connector	J14	Sends signal to scope A portion of dual beam oscilloscope through scope A input switch on primary signal selector panel.
3	Output connector	J13	Sends signal through attenuation network to input 1 of scope B portion of dual beam oscilloscope.
4	Time delay output connector	J26	Connects to output of time delay network.
5	Time delay input connector	J25	Connects signal to input of time delay network.
6	Output connector	J15	Enables signal on J14 to be monitored. (Wired in parallel with J13.)

Figure 1-11. Coaxial Distribution Panel



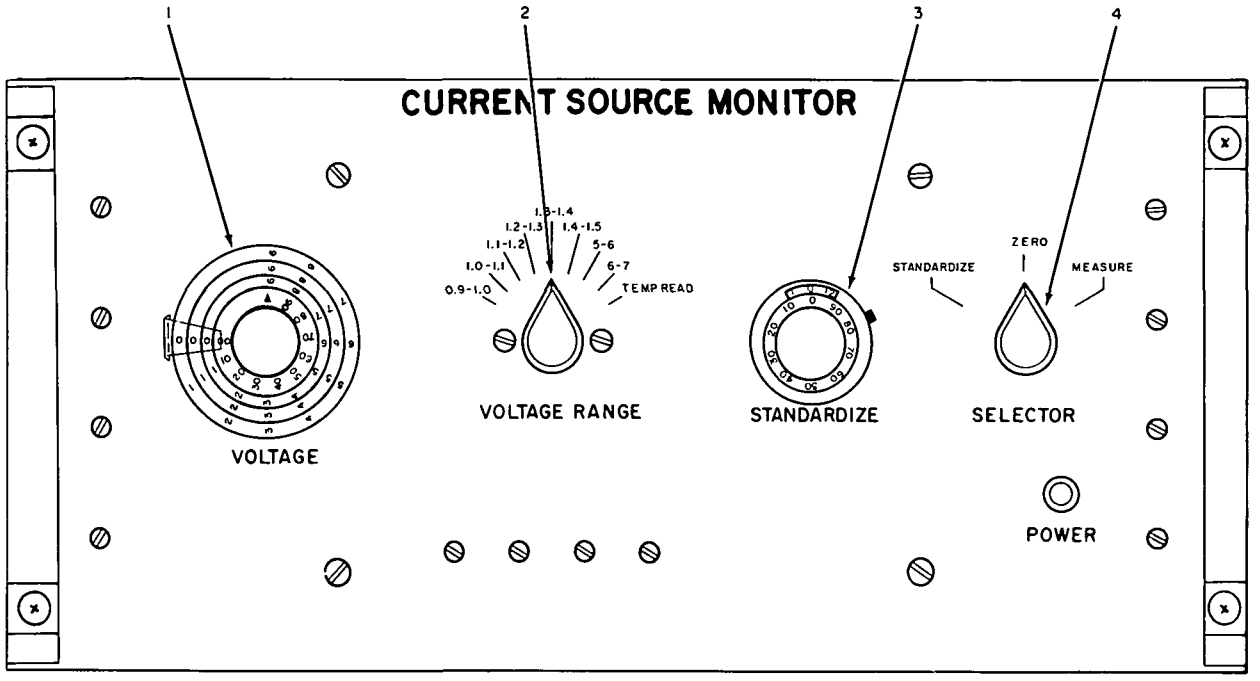
Index No.	Name	Reference Designation	Function
1	SCOPE B INPUT 2 switch	S8	Selects input for input 2 of scope B portion of dual beam oscilloscope.
2	SCOPE B CHANNEL B REF switch	S7	Selects reference signal for scope B portion of dual beam oscilloscope.
3	Channel 3 through 6 DC-AC switches	S1, S2, S4, S5	Each switch selects the mode (dc or ac) in which the correspondingly numbered channel in the oscillograph console operates.
4	REFERENCE switch	S3	Selects, in conjunction with the CHANNEL SELECTORS, the reference signals sent to the oscillograph console.
5	TO PH GEN switch	S6	Determines whether the 800 CPS PHASE GENERATOR uses a reference signal from the ISS or OSS.
6	800 CPS PHASE GENERATOR control	--	Provides a variable-phase, 800-cps reference signal for the dual beam oscilloscope.
7	3200 CPS PHASE GENERATOR control	--	Provides a variable-phase, 3200-cps reference signal for the dual beam oscilloscope.
8	OSCILLOGRAPH SELECTORS switches	A1S1 through A8S1	Select signals to be monitored by the oscillograph consoles. The switches for channels 3 through 6 operate in conjunction with the four DC-AC switches.

Figure 1-12. Oscillograph Signal Selector Panel



Index No.	Name	Reference Designation	Function
1	ΦA, ΦB, and ΦC circuit breaker	CB1	Controls application of power to optics-inertial analyzer.
2	Connector	J2	Connection for applying power and control signals from optics-inertial analyzer to coolant and power console.
3	Connector	J1	Connection for applying three-phase, 115-volt, 60-cps power from external source.

Figure 1-13. AC Power Protection Panel



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Index No.	Name	Reference Designation	Function
1	VOLTAGE control	R36	Provides vernier control of panel output voltage.
2	VOLTAGE RANGE switch	S1	Selects range of panel output voltage.
3	STANDARDIZE control	R27	Provides adjustment for standardizing the panel output voltage.
4	SELECTOR switch	S3	Selects mode of operation for the current source monitor.

Figure 1-14. Current Source Monitor Panel

1-3.1 CROSSBAR SWITCH SIGNALS. (See primary signal selector panel, figure 1-10.) The crossbar switch position is controlled by the TENS and UNITS switches on the primary signal selector panel. The switch position is indicated by the crossbar position indication (3). The crossbar switch outputs (signal 1, and signal 2) are each sent to the digital voltmeter, the phase angle voltmeter, and the scope A portion of the dual beam oscilloscope by the DVM, PAVM, and SCOPE "A" INPUT SIGNAL switches, respectively. Table 1-III identifies the outputs of the crossbar switch at each position. (For a more detailed explanation, see paragraph 4-3.9.2.)

1-3.2 COUNTER INPUTS. (See primary signal selector panel, figure 1-10.) The "A" OR "AB", "D" SIGNAL, "D" PULSE, and D SIGNAL/D PULSE switches select the signals applied to channels A, B, and D of the counter. The outputs of the "A" OR "AB" switch are sent directly to channels A and B; the outputs of the "D" SIGNAL and "D" PULSE switches are sent to channel D through a relay controlled by the D SIGNAL/D PULSE switch. Table 1-IV identifies the counter input signals selected by "A" OR "AB" switch; counter input signals selected by the "D" PULSE and "D" SIGNAL switches are identified in table 1-V. (For a more detailed explanation, see paragraph 4-3.9.1.)

1-3.3 OSCILLOGRAPH INPUTS. The OSCILLOGRAPH SELECTORS (CHANNEL 1 through CHANNEL 8) and the four DC-AC switches on the oscillograph signal selector panel select the signals applied to the eight channels of the oscillograph console. CHANNEL 1, CHANNEL 2, CHANNEL 7, and CHANNEL 8 switches have only one output each; those four outputs are sent directly to their respective channels in the oscillograph console. CHANNEL 3 through CHANNEL 6 have two outputs each, one ac and one dc; these outputs are sent to their respective oscillograph console channels through relays controlled by the four DC-AC switches. Table 1-VI identifies the outputs of the OSCILLOGRAPH SELECTORS. (For a more detailed explanation, see paragraph 4-3.11.)

1-3.4 COAXIAL DISTRIBUTION PANEL SIGNALS. The coaxial distribution panel is used to select the signals sent to the dual beam oscilloscope. The signals on connectors J1 through J12, J16 through J24, and J27 are connected to the dual beam oscilloscope through connectors J13, J14, and J15. Table 1-VII identifies the signals fed into the coaxial distribution panel on each of the input connectors. (For a more detailed explanation, see paragraph 4-3.10.)

1-3.5 AUXILIARY SIGNALS. The auxiliary probe listed in table 1-VII is located in the PSA test point adapter, and is used to connect critical signals from the PSA to the coaxial distribution panel. Table 1-VIII identifies the signals which can be supplied by this probe.

Table 1-III. Crossbar Switch Signal Identification

Crossbar Switch Position		Signal 1	Signal 2
0	0	DC spare	28-volt dc optics prime power
0	1	800-cps, 28-volt, 1-percent 0-phase optics power	800-cps, 28-volt, 5-percent, $\pi/2$-phase optics power
0	2	25.6-kc, 2-volt optics encoder excitation	AC spare
0	3	Direct trunnion control	Trunnion deadzone motor excitation switch
0	4	Direct shaft control	Shaft deadzone motor excitation switch
0	5	Shaft CDU motor drive	Shaft CDU 16-speed error
0	6	Trunnion CDU motor drive	Trunnion CDU 16-speed error
0	7	Shaft CDU tachometer	Trunnion CDU tachometer
0	8	SCT shaft 1/2-speed error	SXT shaft motor drive
0	9	SCT trunnion 1-speed error	SXT trunnion motor drive
1	0	SCT shaft MDA output	SCT trunnion MDA output
1	1	Variable voltage control (optics test)	AC spare
1	2	AC spare	AC spare
1	3	AC spare	AC spare
1	4	AC spare	AC spare

(cont)

Table 1-III. Crossbar Switch Signal Identification (cont)

Crossbar Switch Position		Signal 1	Signal 2
1	5	AC spare	AC spare
1	6	AC spare	AC spare
1	7	DC spare	DC spare
1	8	IMU pressure	DC spare
1	9	800-cps, 28-volt, 5-percent, π/2-phase ISS IMU blower and CDU motor power	IMU temperature control amplifier output
2	0	28-volt dc ISS standby power	28-volt dc ISS operate power
2	1	800-cps, 28-volt, 1-percent, 0-phase ISS power	800-cps stabilization and control system reference
2	2	800-cps, 28-volt, 5-percent, 0-phase ISS gyro wheel power	800-cps, 28-volt, 5-percent, π/2-phase ISS gyro wheel power
2	3	3200-cps, 2-volt, 1-percent ISS power (feedback)	25.6-kc ISS encoder excitation
2	4	-28-volt dc ISS electronics power	12-volt dc gyro pulse torque power
2	5	32-volt dc PIPA pulse torque power	32-volt dc gyro pulse torque power
2	6	120-volt dc PIPA pulse torque power	120-volt dc gyro pulse torque power
2	7	AC spare	Outer gimbal CDU 16-speed error

(cont)

Table 1-III. Crossbar Switch Signal Identification (cont)

Crossbar Switch Position		Signal 1	Signal 2
2	8	AC spare	Middle gimbal CDU 16-speed error
2	9	AC spare	Inner gimbal CDU 16-speed error
3	0	Outer gimbal CDU 1/2-speed error	Outer gimbal CDU 1-speed error
3	1	Middle gimbal CDU 1/2-speed error	Middle gimbal CDU 1-speed error
3	2	Inner gimbal CDU 1/2-speed error	Inner gimbal CDU 1-speed error
3	3	Outer gimbal error (gyro error resolved)	X gyro preamplifier output
3	4	Middle gimbal error (gyro error resolver)	Z gyro preamplifier output
3	5	Inner gimbal error (Y gyro preamplifier output)	Outer gimbal CDU 16-speed error (telemetry)
3	6	Outer gimbal torque motor voltage	Outer gimbal torque motor current
3	7	Middle gimbal torque motor voltage	Middle gimbal torque motor current
3	8	Inner gimbal torque motor voltage	Inner gimbal torque motor current
3	9	$E\Psi_{NB}$ (stabilization and control system signal)	$E\Psi_{NB}$ (stabilization and control system signal)

(cont)

Table 1-III. Crossbar Switch Signal Identification (cont)

Crossbar Switch Position		Signal 1	Signal 2
4	0	$E\Psi_{SC}$ (stabilization and control system signal)	$E\Psi_{SC}$ (stabilization and control system signal)
4	1	$E\theta$ (stabilization and control system signal)	A_{OG} ball attitude indicator resolver cosine
4	2	A_{OG} ball attitude indicator resolver sine	A_{MG} ball attitude indicator resolver cosine
4	3	A_{MG} ball attitude indicator resolver sine	A_{IG} ball attitude indicator resolver cosine
4	4	A_{IG} ball attitude indicator resolver sine	Outer gimbal digital to analog converter output
4	5	Outer gimbal ADA pre-amplifier output	Middle gimbal digital to analog converter output
4	6	Middle gimbal ADA pre-amplifier output	Inner gimbal digital to analog converter output
4	7	Inner gimbal ADA pre-amplifier output	Outer gimbal 16-speed cosine
4	8	Outer gimbal 16-speed sine	Middle gimbal 16-speed cosine
4	9	Middle gimbal 16-speed sine	Inner gimbal 16-speed cosine
5	0	Inner gimbal 16-speed sine	400-cps, 0 to 6.3-volt lamp power
5	1	GSE failure indicator test voltage	X PIPA signal generator output

(cont)

Table 1-III. Crossbar Switch Signal Identification (cont)

Crossbar Switch Position		Signal 1	Signal 2
5	2	Y PIPA signal generator output	Z PIPA signal generator output
5	3	Outer gimbal CDU fail	Middle gimbal CDU fail
5	4	Inner gimbal CDU fail	IMU blower current
5	5	IMU heater current	PIPA temperature
5	6	IRIG temperature	3200-cps square wave, phase A
5	7	Conditioning +20-volt dc	Conditioning +2.5-volt dc
5	8	DC spare	DC spare
5	9	DC spare	DC spare
6	0	3.2-kc ducosyn excitation ISS output	3200-cps square wave, phase B
6	1	Inner gimbal CDU tachometer output	Middle gimbal CDU tachometer output
6	2	Outer gimbal CDU tachometer output	26-volt, 400-cps Hi
6	3	0.5-volt, 400-cps, 0-phase Hi	0.5-volt, 400-cps, π-phase Hi
6	4	AC spare	AC spare
6	5	AC spare	AC spare

(cont)

Table 1-III. Crossbar Switch Signal Identification (cont)

Crossbar Switch Position		Signal 1	Signal 2
6	6	AC spare	AC spare
6	7	DC spare	DC spare
6	8	DC spare	DC spare
6	9	DC spare	DC spare
7	0	+30-volt dc GSE electronics	-30-volt dc GSE electronics
7	1	28-volt dc variable bus remote sense	DC spare
7	2	28-volt dc ISS standby A bus	28-volt dc ISS standby B bus
7	3	28-volt dc ISS operate A bus	28-volt dc ISS operate B bus
7	4	28-volt dc optics A bus	28-volt dc optics B bus
7	5	28-volt dc AGC A bus	28-volt dc AGC B bus
7	6	Signal generator output	Gimbal friction test voltage
7	7	115-volt, 400-cps, A/B	115-volt, 400-cps, 0-phase GSE
7	8	+12-volt dc computer simulator	+3-volt dc computer simulator
7	9	27-volt dc GSE relay power	60-cps GSE phase A power
8	0	60-cps GSE phase B power	60-cps GSE phase C power
8	1	3200-cps, 2-volt GSE suspension power (feedback)	800-cps, 0-phase GSE ISS reference

(cont)

Table 1-III. Crossbar Switch Signal Identification (cont)

Crossbar Switch Position		Signal 1	Signal 2
8	2	3200-cps, 0-phase GSE ISS reference	800-cps, π/2-phase GSE ISS reference
8	3	3200-cps GSE variable phase	800-cps GSE variable phase
8	4	800-cps, 0-phase GSE optics reference	800-cps, π/2-phase GSE optics reference
8	5	400-cps, 115-volt, π-phase GSE	3200-cps, 0-phase IRIG monitor reference
8	6	3200-cps, π/4-phase PIPA monitor reference	AC spare
8	7	3200-cps GSE power supply	AC spare
8	8	AC spare	AC spare
8	9	AC spare	AC spare
9	0	AC spare	AC spare
9	1	Inner gimbal positioner TDA output	DC spare
9	2	Outer gimbal positioner TDA output	Middle gimbal positioner TDA output
9	3	28-volt dc AGC operate power	+13-volt dc AGC
9	4	+3-volt dc AGC	AC spare
9	5	Temperature monitor 1	Temperature monitor 2

(cont)

Table 1-III. Crossbar Switch Signal Identification (cont)

Crossbar Switch Position	Signal 1	Signal 2
9 6	Temperature monitor 3	DC spare
9 7	AC spare	DC spare
9 8	AC spare	DC spare
9 9	AC probe	DC probe

Table 1-IV. Counter D Input Signal Identification

Switch	Position	Signal
"D" SIGNAL	1	28-volt, 800-cps ISS
	2	28-volt, 800-cps optics
	3	2-volt, 25.6-kc ISS
	4	2-volt, 25.6-kc optics
	5	2-volt, 3.2-kc ISS
	6	20-volt, 3.2-kc ISS
	7	6-volt, 400-cps
	8	
	9	Clock sync set
	10	Spare

(cont)

Table 1-IV. Counter D Input Signal Identification (cont)

Switch	Position	Signal
"D" SIGNAL (cont)	11	Spare
	12	Spare
	13	40-second time delay ISS
	14	Auxiliary input jack
	15	
"D" PULSE	1	X IRIG pulse torque electronics ±T
	2	Y IRIG pulse torque electronics ±T
	3	Z IRIG pulse torque electronics ±T
	4	Inner gimbal CDU ± $\Delta \theta$
	5	Middle gimbal CDU ± $\Delta \theta$
	6	Outer gimbal CDU ± $\Delta \theta$
	7	Inner gimbal CDU digital to analog converter ±C
	8	Middle gimbal CDU digital to analog converter ±C
	9	Outer gimbal CDU digital to analog converter ±C
	10	X PIPA ± ΔV
	11	Y PIPA ± ΔV
	12	Z PIPA ± ΔV
	13	Spare

(cont)

Table 1-IV. Counter D Input Signal Identification (cont)

Switch	Position	Signal
"D" PULSE (cont)	14	Spare
	15	±Auxiliary input jack
	16	Trunnion ± $\Delta \theta$
	17	Shaft ± $\Delta \theta$
	18	Spare
	19	Spare
	20	Spare
	21	Spare
	22	Spare
	23	Auxiliary input jack

Table 1-V. Counter A and B Inputs Signal Identification

Switch	Position	Deck A	Deck B
"A" OR "AB"	1	X IRIG pulse torque electronics +T	X IRIG pulse torque electronics -T
	2	Y IRIG pulse torque electronics +T	Y IRIG pulse torque electronics -T
	3	Z IRIG pulse torque electronics +T	Z IRIG pulse torque electronics -T

(cont)

Table 1-V. Counter A and B Inputs Signal Identification (cont)

Switch	Position	Deck A	Deck B
"A" OR "AB" (cont)	4	Inner gimbal CDU + $\Delta\theta$	Inner gimbal CDU - $\Delta\theta$
	5	Middle gimbal CDU + $\Delta\theta$	Middle gimbal CDU - $\Delta\theta$
	6	Outer gimbal CDU + $\Delta\theta$	Outer gimbal CDU - $\Delta\theta$
	7	Inner gimbal CDU digital to analog converter +C	Inner gimbal CDU digital to analog converter -C
	8	Middle gimbal CDU digital to analog converter +C	Middle gimbal CDU digital to analog converter -C
	9	Outer gimbal CDU digital to analog converter +C	Outer gimbal CDU digital to analog converter -C
	10	X PIPA + ΔV	X PIPA - ΔV
	11	Y PIPA + ΔV	Y PIPA - ΔV
	12	Z PIPA + ΔV	Z PIPA - ΔV
	13	Spare	Spare
	14	Spare	Spare
	15	+Auxiliary input jack	-Auxiliary input jack
	16	Trunnion + $\Delta\theta$	Trunnion - $\Delta\theta$
	17	Shaft + $\Delta\theta$	Shaft - $\Delta\theta$
	18	Inner gimbal CDU + $\Delta\theta$	Inner gimbal CDU digital to analog converter +C
	19	Inner gimbal CDU - $\Delta\theta$	Inner gimbal CDU digital to analog converter -C

(cont)

Table 1-V. Counter A and B Inputs Signal Identification (cont)

Switch	Position	Deck A	Deck B
"A" OR "AB" (cont)	20	Middle gimbal CDU + $\Delta\theta$	Middle gimbal CDU digital to analog converter +C
	21	Middle gimbal CDU - $\Delta\theta$	Middle gimbal CDU digital to analog converter -C
	22	Outer gimbal CDU + $\Delta\theta$	Outer gimbal CDU digital to analog converter +C
	23	Outer gimbal CDU - $\Delta\theta$	Outer gimbal CDU digital to analog converter -C

Table 1-VI. Oscillograph Inputs Signal Identification

Channel	Position	DC Signal	AC Signal
1	1	None	GSE failure indicator test voltage
	2	None	Inner gimbal error (Y IRIG preamplifier output)
	3	None	Outer gimbal CDU 1/2-speed error
	4	None	Middle gimbal CDU 1-speed error
	5	None	Inner gimbal CDU 16-speed error
	6	None	$E\Psi_{SC}$ (stabilization and control system signal)

(cont)

Table 1-VI. Oscillograph Inputs Signal Identification (cont)

Channel	Position	DC Signal	AC Signal
1 (cont)	7	None	Spare
	8	None	Spare
	9	None	None
	10	None	Spare
	11	None	SXT shaft motor drive
	12	None	SXT trunnion motor drive
	13	None	Shaft deadzone
	14	None	None
	AUX	None	Auxiliary ac
2	1	None	X IRIG preamplifier output
	2	None	Middle gimbal error (gyro error resolver)
	3	None	Inner gimbal CDU 1/2-speed error
	4	None	Outer gimbal CDU 1-speed error
	5	None	Middle gimbal CDU 16-speed error
	6	None	$E\,\Phi_{sc}$ (stabilization and control system signal)
	7	None	Spare

(cont)

Table 1-VI. Oscillograph Inputs Signal Identification (cont)

Channel	Position	DC Signal	AC Signal
2 (cont)	8	None	Spare
	9	None	None
	10	None	Spare
	11	None	Shaft CDU tachometer
	12	None	Trunnion CDU tachometer
	13	None	Trunnion deadzone
	14	None	None
	AUX	None	Auxiliary ac
3	1	Spare	Z IRIG preamplifier output
	2	Spare	Outer gimbal error (gyro error resolver)
	3	PIPA temperature	Middle gimbal CDU 1/2-speed error
	4	-28-volt dc ISS electronics power	Inner gimbal CDU 1-speed error
	5	Spare	Outer gimbal CDU 16-speed error
	6	Outer gimbal encoder level B	$E\theta$ (stabilization and control system signal)
	7	Spare	Spare

(cont)

Table 1-VI. Oscillograph Inputs Signal Identification (cont)

Channel	Position	DC Signal	AC Signal
3 (cont)	8	None	Spare
	9	None	None
	10	None	Spare
	11	-30-volt dc GSE electronics	Direct shaft control
	12	None	SCT trunnion 1-speed error
	13	None	SCT shaft MDA output
	14	AGC register no. 6	None
	AUX	Auxiliary dc	Auxiliary ac
4	1	Spare	Z PIPA signal generator output
	2	Spare	Outer gimbal digital to analog converter output
	3	IRIG temperature	Outer gimbal CDU fail
	4	28-volt dc ISS operate power	Outer gimbal 16-speed sine
	5	12-volt dc gyro pulse torque power	800-cps spare
	6	Outer gimbal encoder level A	$E\ \Phi_{NB}$ (stabilization and control system signal)
	7	Spare	Spare

(cont)

Table 1-VI. Oscillograph Inputs Signal Identification (cont)

Channel	Position	DC Signal	AC Signal
4 (cont)	8	None	Spare
	9	28-volt dc optics prime power	None
	10	None	Spare
	11	+30-volt dc GSE electronics	SCT shaft 1/2-speed error
	12	None	Direct trunnion control
	13	None	SCT trunnion MDA output
	14	AGC register no. 5	None
	AUX	Auxiliary dc	Auxiliary ac
5	1	Signal generator output	Y PIPA signal generator output
	2	Spare	Middle gimbal digital to analog converter output
	3	Spare	Middle gimbal CDU fail
	4	IMU blower current	Middle gimbal 16-speed sine
	5	32-volt dc gyro pulse torque power	800-cps spare
	6	Middle gimbal encoder level B	E Ψ_{NB} (stabilization and control system signal)
	7	Trunnion encoder level B	3200-cps, 2-volt, 1-percent, ISS power

(cont)

Table 1-VI. Oscillograph Inputs Signal Identification (cont)

Channel	Position	DC Signal	AC Signal
5 (cont)	8	None	Spare
	9	Spare	None
	10	None	Spare
	11	Test control variable dc	Shaft CDU motor drive
	12	None	Trunnion CDU motor drive
	13	None	800-cps, 28-volt, 5-percent, optics power
	14	AGC register no. 4	None
	AUX	Auxiliary dc	Auxiliary ac
6	1	Inner gimbal ADA pre-amplifier output	X PIPA signal generator output
	2	Middle gimbal torque motor current	Inner gimbal digital to analog converter output
	3	Outer gimbal torque motor voltage	Inner gimbal CDU fail
	4	IMU heater current	Inner gimbal 16-speed sine
	5	120-volt dc gyro pulse torque power	800-cps spare
	6	Middle gimbal encoder level A	800-cps, 28-volt, 1-percent, ISS power
	7	Trunnion encoder level A	800-cps, 28-volt, 5-percent, 0-phase ISS gyro wheel power

(cont)

Table 1-VI. Oscillograph Inputs Signal Identification (cont)

Channel	Position	DC Signal	AC Signal
6 (cont)	8	None	800-cps, 28-volt, 5-percent, ISS IMU blower and CDU motor power
	9	Spare	None
	10	None	Spare
	11	27-volt dc GSE relay power	Shaft CDU 16-speed error
	12	None	Trunnion CDU 16-speed error
	13	None	800-cps, 28-volt, 1-percent, optics power
	14	AGC register no. 3	None
	AUX	Auxiliary dc	Auxiliary ac
7	1	Inner gimbal torque motor current	None
	2	Middle gimbal torque motor voltage	None
	3	Outer gimbal ADA pre-amplifier output	None
	4	G and N failure indicator	None
	5	32-volt dc PIPA pulse torque power	None
	6	Inner gimbal encoder level B	None

(cont)

Table 1-VI. Oscillograph Inputs Signal Identification (cont)

Channel	Position	DC Signal	AC Signal
7 (cont)	7	Shaft encoder level B	None
	8	None	None
	9	Spare	None
	10	None	None
	11	28-volt dc ISS standby power	None
	12	None	None
	13	None	None
	14	AGC register no. 2	None
	AUX	Auxiliary dc	None
8	1	Inner gimbal torque motor voltage	None
	2	Middle gimbal ADA pre-amplifier output	None
	3	Outer gimbal torque motor current	None
	4	GSE failure indicator voltage	None
	5	120-volt dc PIPA pulse torque power	None
	6	Inner gimbal encoder level A	None
	7	Shaft encoder level A	None

(cont)

Table 1-VI. Oscillograph Inputs Signal Identification (cont)

Channel	Position	DC Signal	AC Signal
8 (cont)	8	None	None
	9	PIPA inhibit	None
	10	None	None
	11	28-volt dc remote sense	None
	12	None	None
	13	None	None
	14	AGC register no. 1	None
	AUX	Auxiliary dc	None

Table 1-VII. Coaxial Distribution Panel Signal Identification

Coaxial Connector	Signal
J1	Inner gimbal encoder electronics + $\Delta\theta$
J2	Inner gimbal encoder electronics - $\Delta\theta$
J3	Middle gimbal encoder electronics + $\Delta\theta$
J4	Middle gimbal encoder electronics - $\Delta\theta$
J5	Outer gimbal encoder electronics + $\Delta\theta$
J6	Outer gimbal encoder electronics - $\Delta\theta$
J7	CDU fail bit

(cont)

Table 1-VII. Coaxial Distribution Panel Signal Identification (cont)

Coaxial Connector	Signal
J8	IMU fail bit
J9	Accelerometer fail bit
J10	X PIPA + ΔV
J11	X PIPA - ΔV
J12	Y PIPA + ΔV
J16	Y PIPA - ΔV
J17	Z PIPA + ΔV
J18	Z PIPA - ΔV
J19	800-cps power supply set pulse
J20	3200-cps power supply set pulse
J21	CDU trunnion + $\Delta \theta$
J22	CDU trunnion - $\Delta \theta$
J23	CDU shaft + $\Delta \theta$
J24	CDU shaft - $\Delta \theta$
J27	Auxiliary probe (PSA test point adapter)*
	*See table 1-VIII for signals available to probes

Table 1-VIII. Auxiliary Signal Identification

Signal No.	Signal
1	AGC clock
2	+ $\Delta\theta$ CDU command
3	- $\Delta\theta$ CDU command
4	+ $\Delta\theta$ CDU command
5	- $\Delta\theta$ CDU command
6	+ $\Delta\theta$ CDU command
7	- $\Delta\theta$ CDU command
8	PIPA interrogate pulse
9	PIPA clock pulse
10	X IRIG + command
11	X IRIG - command
12	Y IRIG + command
13	Y IRIG - command
14	Z IRIG + command
15	Z IRIG - command
16	IRIG reset pulse
17	102,400 pps pulse
18	25,600 pps set pulse
19	25,600 pps reset pulse

(cont)

Table 1-VIII. Auxiliary Signal Identification (cont)

Signal No.	Signal
20	12,800 pps set pulse
21	3200-pps reset pulse
22	800-pps reset pulse

1-3.6 OSCILLOSCOPE REFERENCE SIGNALS. Table 1-IX identifies the signals coupled to the oscilloscope reference inputs by SCOPE B CHANNEL B REF switch and SCOPE "A" INPUT REFERENCE switch. The signals are identical for both switches.

Table 1-IX. Oscilloscope Reference Input Signals

Switch Position	Signal
1	800 cps ISS zero phase
2	800 cps variable phase, ISS or OSS
3	3200 cps ISS zero phase
4	3200 cps ISS variable phase
5	800 cps OSS zero phase
6	Spare
7	Spare
8	Spare

1-4 POWER REQUIREMENTS

Only 115-volt, 60-cps, three-phase power is required for operation of the optics-inertial test set.

Chapter 2

PREPARATION FOR USE AND SHIPMENT

2-1 INTRODUCTION

The components of the optics-inertial analyzer are preserved and packed for level A, level B, or level C storage. All shipments are assumed to be level C unless job description cards (JDC's) or specific shipping orders received in the field indicate otherwise. Shipment instructions in this manual are provided for use from the field to the factory or from one field location to another.

Level A preservation and packing is used when the equipment is intended for storage for an indeterminate period. When equipment is stored a maximum of 180 days, level B is used. Level C is used for equipment intended for immediate use.

All shipments except small, low-value items and mated or matched parts are shipped in unit packages of one. However, shipping containers may contain varying numbers of unit packages.

2-2 GENERAL UNPACKING AND PACKING INSTRUCTIONS

The following procedures are general unpacking and packing instructions applicable to all equipment. JDC 19500 gives detailed packing instructions. Refer to commercial equipment manuals for any additional special handling or shipping instructions for the commercial components.

> CAUTION: Some equipment is shipped in containers marked REUSABLE CONTAINER. These must be retained in storage for reshipment of the equipment.

(1) Flatten and store fiberboard cartons if they can be restored to their original shape and strength for reshipment. Identify cartons for future use.

(2) Store cushioning material, blocks, and separators with the carton from which they came.

NOTE: All packing JDC's will describe all expendable materials which cannot be salvaged and must be obtained locally.

(3) Retain protective devices and attaching screws that are used to protect critically machined surfaces having tapped holes. The protective devices must be reinstalled for reshipment.

(4) Replace original packing material that has been lost or destroyed with locally procured material which will insure a tight, rattle-free package and protect the equipment from handling and corrosion damage.

(5) Place inner cartons inside outer cartons so that closure of inner carton is 180 degrees from closure of outer carton.

JOB: PACKING OF OPTICS-INERTIAL TEST SET EQUIPMENT	**JDC** 19500 (Sheet 1 of 14)
SUBSYSTEM:	**ASSEMBLY:**
DESCRIPTION: Pack optics-inertial test set equipment for shipment at immediate use level.	**TYPE:** Pack **INTERVAL:** As required
TOOLS AND MATERIAL: Procedures 10 and 15 require fork lift truck	**REFERENCES:**
IMPORTANT: See below	

IMPORTANT: The information in the preparation section should be performed for all components of the optics-inertial test set equipment. However, this JDC contains 15 procedures. Each component of the optics-inertial test set equipment requires only 1 procedure.

A. PREPARATION

1. Wipe unit free of surface dirt.
2. Insure that records and tags required by local administrative procedure are securely affixed.
3. Retrieve required packing materials from storage.
4. Refer to exploded view of representative pack as an aid in performing procedures.
5. Refer to the table of packing materials and procedure reference for reference to the applicable procedure for each component of the optics-inertial test set equipment.

B. PROCEDURE - 1

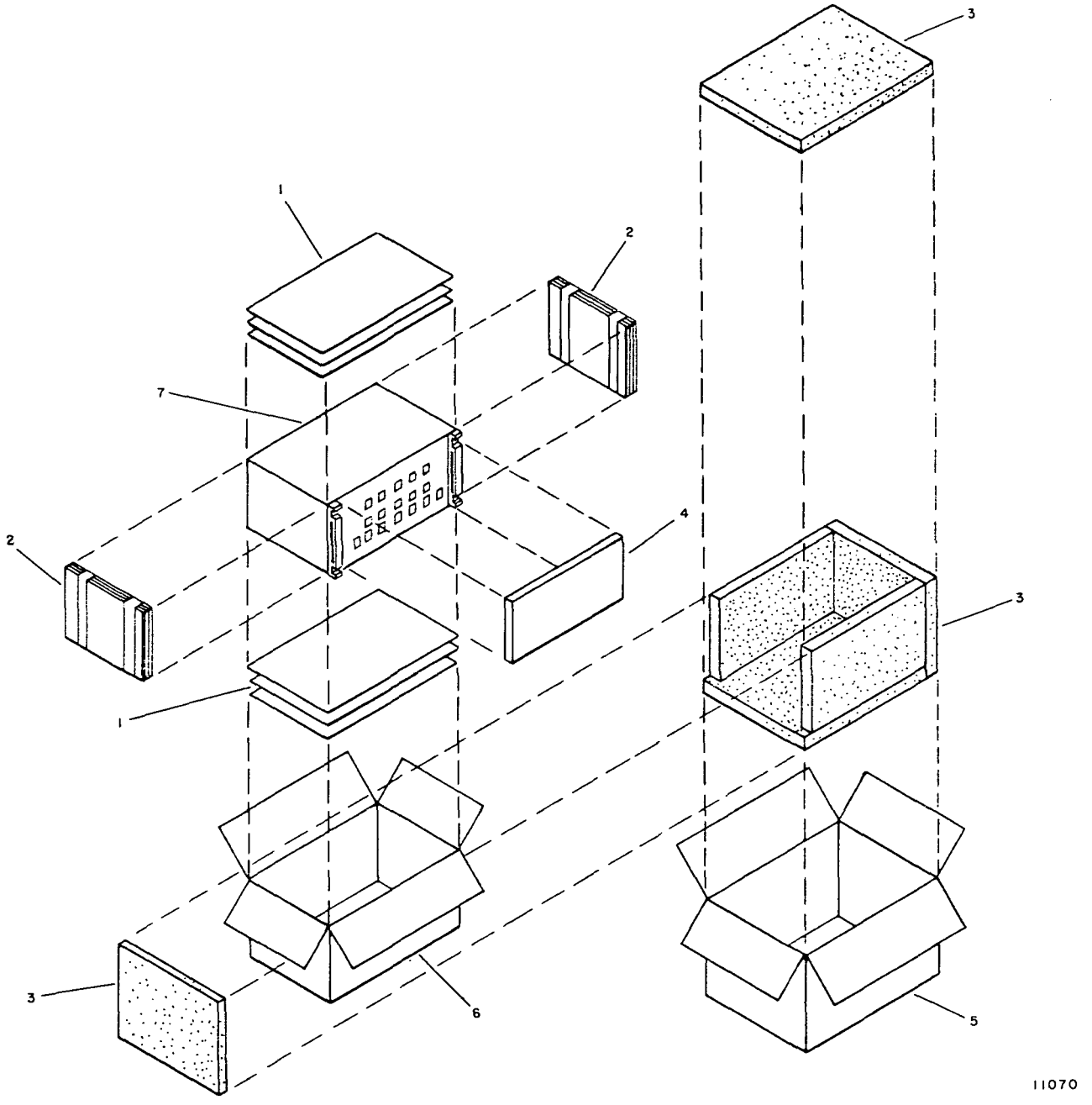
1. Insure that dust covers are protecting electrical connectors on back of unit.
2. Place fiberboard tray over front of unit to protect controls and other protrusions. The fiberboard tray should fit snugly over controls and between panel handles.

   NOTE: Refer to table of packing materials and procedure reference for the number and size of fiberboard sheets required.

3. Place fiberboard sheets on bottom of inner carton.
4. Place unit in inner carton.

   NOTE: See size column of table for dimensions of fiberboard sheets.

5. Fabricate fiberboard pads by taping several fiberboard sheets together.
6. Place one fiberboard pad on each side



1. Fiberboard sheets
2. Fiberboard pads
3. Bound-hair cushioning
4. Fiberboard tray
5. Outer carton
6. Inner carton
7. Component to be packed

Exploded View of Representative Pack

Table of Packing Materials and Procedure Reference

Unit Name	Part Number	Procedure B	Cushioning Thickness (inches)	Tray Required	Fiberboard Sheet Size (inches)	Fiberboard	
						Top (inches)	Bottom (inches)
AGE COOLANT AND POWER CONSOLE							
Cabinet assembly	1900677	10 (Vinyl pouch 54 by 36 by 84 inches)					
Coolant supply	1900098-011	15					
Current source monitor	1900053-011	13	3	Yes	18 by 4	6 sheets (18 by 19)	6 sheets (18 by 19)
Galvanometer assembly	1900034-011	13	2	Yes	12-3/4 by 4	8 sheets (12-3/4 by 19)	5 sheets (12-3/4 by 19)
Power supply panel	1900033-011	14	4	No	18-1/2 by 14, 18-1/2 by 19	1 sheet (18-1/2 by 19)	
CABLE INTERCONNECT							
			(To be supplied)				
GSE JUNCTION BOX							
			(To be supplied)				
PSA TEST POINT ADAPTER							
			(To be supplied)				

(cont)

Table of Packing Materials and Procedure Reference (cont)

Unit Name	Part Number	Procedure B	Cushioning Thickness (inches)	Tray Required	Fiberboard Sheet Size (inches)	Fiberboard	
						Top (inches)	Bottom (inches)
OPTICS-INERTIAL ANALYZER							
AC power protection panel	1900075-011	1	2	Yes	9 by 6	4 sheets (20 by 9)	4 sheets (20 by 9)
Centrifugal fan	19000350-011	9	2	No	19-1/2 by 6, 17 by 7	5 sheets (19-1/2 by 19)	5 sheets (19-1/2 by 19)
Coaxial distribution panel	1900166-011	1	2	No	10 by 4	3 sheets (19 by 10)	2 sheets (19 by 10)
Counter	1900041-011	1	2-1/2	Yes	22 by 3	7 sheets (22 by 19)	5 sheets (22 by 19)
Crossbar switch	1900048-011	3	2	Yes	(Polyethylene pouch 28 by 32 inches)		
Digital recorder panel	1900052-011	5	3	Yes	22 by 6-1/4, 19 by 6		4 sheets (19 by 22)
Digital voltmeter	1900042-011	1	3	Yes	23 by 5	5 sheets (23 by 19)	7 sheets (23 by 19)
Dual beam oscilloscope	1900037-011	1	3	Yes	24-1/4 by 8	6 sheets (24-1/4 by 19)	5 sheets (24-1/4 by 19)
Electrical equipment cabinet	1900031-011	10	(Vinyl pouch 100 by 80 by 32 inches)				
Electronics power supply	1900035-011	2	3	Yes	16 by 3	AR (16 by 17)	4 sheets (16 by 19)

(cont)

Table of Packing Materials and Procedure Reference (cont)

Unit Name	Part Number	Procedure B	Cushioning Thickness (inches)	Tray Required	Fiberboard Sheet Size (inches)	Fiberboard	
						Top (inches)	Bottom (inches)
OPTICS-INERTIAL ANALYZER							
Gimbal position control panel	1900054-011	1	3	Yes	21 by 3	3 sheets (21 by 18)	3 sheets (21 by 18)
Monitor oscilloscope	1900038-011	1	2-1/2	Yes	20 by 4	6 sheets (20 by 19)	4 sheets (20 by 19)
Monitor panel	1900055-011	1	3	Yes	20 by 5	3 sheets (20 by 19)	3 sheets (20 by 19)
Oscilloscope signal selector panel	1900056-011	1	2-1/2	Yes	20 by 6-3/4	3 sheets (20 by 19)	3 sheets (20 by 19)
Phase angle voltmeter	1900036-011	1	2	Yes	14 by 3	6 sheets (14 by 19)	5 sheets (14 by 19)
Phase shift panel	1900163-011	8		No	6 by 1-1/2	3 sheets (19 by 6)	3 sheets (19 by 6)
Power supply and load panel	1900060-011	1	2-1/2	Yes	20 by 3	3 sheets (20 by 19)	3 sheets (20 by 19)
Primary signal selector panel	1900057-011	1	2-1/2	Yes	20 by 10	3 sheets (20 by 19)	3 sheets (20 by 19)
Relay and lamp power supply	1900049-011	4	4	Yes	18 by 6	7 sheets (18 by 19)	5 sheets (18 by 19)
Signal generator	1900043-011	1	2	Yes	15 by 6	5 sheets (19 by 15)	5 sheets (19 by 15)

(cont)

Table of Packing Materials and Procedure Reference (cont)

Unit Name	Part Number	Procedure B	Cushioning Thickness (inches)	Tray Required	Fiberboard Sheet Size (inches)	Fiberboard	
						Top (inches)	Bottom (inches)
OPTICS-INERTIAL ANALYZER							
Temperature monitor and control panel	1900058-011	1	3	Yes	20 by 6-3/4	3 sheets (20 by 19)	3 sheets (20 by 19)
Test control panel	1900059-011	6	2-1/2	Yes	20 by 8, 20 by 2-1/4		3 sheets (20 by 19)
Test selector panel	1900082-011	7	2-1/2	Yes	20 by 10, 20 by 4		3 sheets (20 by 19)
OSCILLOGRAPH CONSOLE							
Electrical equipment cabinet	1900265	10	(Vinyl pouch 46 by 30 by 80 inches)				
Fan assembly	1900350-021	9	2	No			
Oscillograph	1900047-011	12	3-1/2	Yes	14 by 3-1/2, 14 by 13, 9-1/4 by 6, 6-1/2 by 16-3/4	2 sheets (20-1/2 by 19)	6 sheets (14 by 19)
Oscillograph amplifier	1900044-011	1	3-1/2	Yes	24-1/4 by 8	6 sheets (24-1/4 by 19)	4 sheets (24-1/4 by 19)
Oscillograph amplifier	1900045-011	1	3-1/2	Yes	24-1/4 by 8	6 sheets (24-1/4 by 19)	4 sheets (24-1/4 by 19)
Oscillograph control	1900046-011	1	2	No	8 by 3	7 sheets (8 by 19)	6 sheets (8 by 19)

(cont)

Table of Packing Materials and Procedure Reference (cont)

Unit Name	Part Number	Procedure B	Cushioning Thickness (inches)	Tray Required	Fiberboard Sheet Size (inches)	Fiberboard	
						Top (inches)	Bottom (inches)
OSCILLOGRAPH CONSOLE							
Oscillograph pen control	1900164-011	1	2	Yes	10 by 3	6 sheets (19 by 10)	7 sheets (19 by 10)
Remote counter indication	1900039-011	11	2	Yes	18 by 3, 19 by 7	3 sheets (18 by 19)	5 sheets (18 by 19)

of unit. The fiberboard pad shall be thick enough to insure that the unit fits snugly in the inner carton.

NOTE: Refer to table for number and size of fiberboard sheets required.

7. Place fiberboard sheets on top of unit.
8. Seal and mark inner carton to identify contents.
9. Insure that inner carton is rattle-free.

NOTE: Refer to table for thickness of cushioning material required.

10. Line four sides and bottom of outer carton with bound-hair cushioning.
11. Insert inner carton into outer carton.
12. Place bound-hair cushioning on top of inner carton.
13. Seal and mark outer carton in accordance with local carrier's requirements.
14. Insure that outer carton is rattle-free.

B. PROCEDURE - 2

1. Insure that dust covers are protecting electrical connectors on back of unit.
2. Place fiberboard tray over front panel of unit to protect controls and other protrusions.
3. Place four 16-inch by 19-inch fiberboard sheets on bottom of inner carton.
4. Fabricate fiberboard pad by taping several 16-inch by 3-inch fiberboard sheets together.
5. Turn unit upside down and place in inner carton.
6. Place one fiberboard pad on each side of unit. The fiberboard pad shall be thick enough to insure that the unit fits snugly in the inner carton.
7. Tape several sheets of 16-inch by 17-inch fiberboard to top of unit.
8. Seal inner carton and turn so unit is now right side up.
9. Mark inner carton to identify contents.
10. Insure that inner carton is rattle-free.
11. Line four sides and bottom of outer carton with 3-inch thick, bound-hair cushioning.
12. Insert inner carton into outer carton.
13. Place 3-inch thick, bound-hair cushioning on top of inner carton.
14. Seal and mark outer carton in accordance with local carrier's requirements.
15. Insure that outer carton is rattle-free.

B. PROCEDURE - 3

1. Insure that dust covers are protecting electrical connectors on back of unit.
2. Place unit in a 28-inch by 32-inch polyethylene pouch and seal pouch.
3. Place unit in inner carton, with handle of unit at top of carton.
4. Place fiberboard tray on top of unit, covering handle.
5. Seal and mark inner carton to identify contents.
6. Insure that inner carton is rattle-free.
7. Line four sides and bottom of outer carton with 2-inch thick, bound-hair cushioning.

8. Insert inner carton into outer carton.
9. Place 2-inch thick, bound-hair cushioning on top of inner carton.
10. Seal and mark outer carton in accordance with local carriers's requirements.
11. Insure that outer carton is rattle-free.

B. PROCEDURE - 4

1. Insure that dust covers are protecting electrical connectors on back of unit.

NOTE: Five-panel liner is strip of fiberboard folded four times to make overlapping liner.

2. Place five-panel liner in fiberboard tray and put fiberboard tray with liner over face of unit.
3. Place five 18-inch by 19-inch fiberboard sheets on bottom of inner carton.
4. Place unit in inner carton.
5. Place five 18-inch by 6-inch fiberboard sheets on each side of unit.
6. Place seven 18-inch by 19-inch fiberboard sheets on top of unit.
7. Seal and mark inner carton to identify contents.
8. Insure that inner carton is rattle-free.
9. Line four sides and bottom of outer carton with 4-inch thick, bound-hair cushioning.
10. Insert inner carton into outer carton.
11. Place 4-inch thick, bound-hair cushioning on top of inner carton.
12. Seal and mark outer carton in accordance with local carrier's requirements.
13. Insure that outer carton is rattle-free.

B. PROCEDURE - 5

1. Insure that dust covers are protecting electrical connectors on back of unit.
2. Place four 22-inch by 19-inch fiberboard sheets on bottom of inner carton.
3. Place fiberboard tray over front panel of unit to protect controls and other protrusions.
4. Turn unit upside down and place in inner carton.
5. Fabricate fiberboard pad by taping several 22-inch by 6-1/4 inch fiberboard sheets together.
6. Place one fiberboard pad on each side of unit. The fiberboard pad shall be thick enough to insure that the unit fits snugly in the inner carton.
7. Fabricate two fiberboard pads by taping several 19-inch by 6-inch fiberboard sheets together.
8. Place one fiberboard pad on bottom of unit in the first section between the steel angles. Press pad down firmly so that the protruding screws penetrate the fiberboard pad.
9. Place second fiberboard pad on bottom of unit in the third section between the steel angles. Press pad down firmly so that the protruding screws penetrate the fiberboard pad.
10. Seal inner carton and turn so unit is right side up.

11. Mark inner carton to identify contents.
12. Insure that inner carton is rattle-free.
13. Line four sides and bottom of outer carton with 3-inch thick, bound-hair cushioning.
14. Insert inner carton into outer carton.
15. Place 3-inch thick, bound-hair cushioning on top of inner carton.
16. Seal and mark outer carton in accordance with local carrier's requirements.
17. Insure that outer carton is rattle-free.

B. PROCEDURE - 6

1. Insure that dust covers are protecting electrical connectors on back of unit.
2. Place fiberboard tray over front panel of unit to protect controls and other protrusions.
3. Place three 20-inch by 19-inch fiberboard sheets on bottom of inner carton.
4. Place unit in inner carton.
5. Fabricate two fiberboard pads by taping several 20-inch by 8-inch fiberboard sheets together. Fabricate two smaller fiberboard pads by taping several 20-inch by 2-1/4-inch fiberboard sheets together.
6. Secure each 20-inch by 8-inch fiberboard pad to each 20-inch by 2-1/4-inch fiberboard pad by taping along the 20-inch edges.
7. Place one fiberboard pad on each side of the unit so that the small pad catches on the top frame of the unit and the large pad blocks out the side of the unit.
8. Seal and mark inner carton to identify contents.
9. Insure that inner carton is rattle-free.
10. Line four sides and bottom of outer carton with 2-1/2-inch thick, bound-hair cushioning.
11. Insert inner carton into outer carton.
12. Place 2-1/2-inch thick, bound-hair cushioning on top of inner carton.
13. Seal and mark outer carton in accordands with local carrier's requirements.
14. Insure that outer carton is rattle-free.

B. PROCEDURE - 7

1. Insure that dust covers are protecting electrical connectors on back of unit.
2. Place fiberboard tray over front panel of unit to protect controls and other protrusions.
3. Place three 20-inch by 19-inch fiberboard sheets on bottom of inner carton.
4. Place unit in inner carton.
5. Fabricate two fiberboard pads by taping several 20-inch by 10-inch fiberboard sheets together. Fabricate two smaller fiberboard pads by taping several 20-inch by 4-inch fiberboard sheets together.
6. Secure each 20-inch by 10-inch fiberboard pad to each 20-inch by 4-inch fiberboard pad by taping along the 20-inch edges.
7. Place one fiberboard pad on each side of the unit so that the small pad catches on the top frame of the unit and the large pad blocks out the side of the unit.
8. Seal and mark inner carton to identify contents.

9. Insure that inner carton is rattle-free.
10. Line four sides and bottom of outer carton with 2-1/2-inch thick, bound-hair cushioning.
11. Insert inner carton into outer carton.
12. Place 2-1/2-inch thick, bound-hair cushioning on top of inner carton.
13. Seal and mark outer carton in accordance with local carrier's requirements.
14. Insure that outer carton is rattle-free.

B. PROCEDURE - 8

1. Insure that dust covers are protecting electrical connectors on back of unit.
2. Place three 19-inch by 6-inch fiberboard sheets on bottom of inner carton.
3. Place unit in inner carton.
4. Place five 6-inch by 1-1/2-inch fiberboard sheets on each side of unit.
5. Place three 19-inch by 6-inch fiberboard sheets on top of unit.
6. Seal and mark inner carton to identify contents.
7. Insure that inner carton is rattle-free.
8. Wrap 60-inch by 36-inch by 1/2-inch wadding around inner carton.
9. Insert wrapped inner carton into outer carton.
10. Seal and mark outer carton in accordance with local carrier's requirements.
11. Insure that outer carton is rattle-free.

B. PROCEDURE - 9

1. Insure that dust covers are protecting electrical connectors on back of unit.
2. Place five 19-inch by 19-1/2-inch fiberboard sheets on bottom of inner carton.
3. Place unit in inner carton.
4. Place five 19-1/2-inch by 6-inch fiberboard sheets on each side of unit.
5. Place five 19-1/2-inch by 19-inch fiberboard sheets on top of unit.
6. Place one 17-inch by 7-inch fiberboard sheet in front of unit.
7. Seal and mark inner carton to identify contents.
8. Insure that inner carton is rattle-free.
9. Line four sides and bottom of outer carton with 2-inch thick, bound-hair cushioning.
10. Insert inner carton into outer carton.
11. Place 2-inch thick, bound-hair cushioning on top of inner carton.
12. Seal and mark outer carton in accordance with local carrier's requirements.
13. Insure that outer carton is rattle-free.

B. PROCEDURE - 10

1. Secure loose connectors, cables, and drawer slides to cabinet.

a. Cover each connector with a polyethylene bag.
b. Wrap 1/4-inch wadding around each connector, overlapped so that it covers the end of the connector.
c. Tape connector to cabinet with 2-inch wide, water-resistant, pressure-sensitive adhesive paper tape.
d. Tape cables and drawer slides to cabinet with 1-inch wide, filament-reinforced, pressure-sensitive adhesive tape.

2. Close and latch cabinet doors.
3. Using fork lift, place cabinet on top of skidded package base and bolt down, using bolts provided with skidded package base.

NOTE: Refer to table of packing materials and procedure reference for required size of vinyl pouch.

4. Cover unit with 100-inch by 80-inch by 32-inch vinyl pouch.
5. Secure pouch to skidded package assembly by stapling or tuck pouch under cabinet to secure.
6. Complete assembly of the crate assembly by using appropriate nailing/bolting techniques.
7. Mark for shipment in accordance with local carrier's requirements.

B. PROCEDURE - 11

1. Insure that dust covers are protecting electrical connectors on back of unit.
2. Place five 19-inch by 18-inch fiberboard sheets into bottom of inner carton.
3. Place fiberboard tray over front panel of unit between handles. The fiberboard tray should fit snugly between panel handles.
4. Place unit in inner carton.
5. Place five 18-inch by 3-inch fiberboard sheets on each side of unit.
6. Place three 18-inch by 19-inch fiberboard sheets on top of unit.
7. Place one 19-inch by 7-inch fiberboard sheet in front of unit so that unit will fit snugly in inner carton.
8. Seal and mark inner carton to identify contents.
9. Insure that inner carton is rattle-free.
10. Line four sides and bottom of outer carton with 2-inch thick, bound-hair cushioning.
11. Insert inner carton into outer carton.
12. Place 2-inch thick, bound-hair cushioning on top of inner carton.
13. Seal and mark outer carton in accordance with local carrier's requirements.
14. Insure that outer carton is rattle-free.

B. PROCEDURE - 12

1. Insure that dust covers are protecting electrical connectors on back of unit.

NOTE: Five-panel liner is strip of fiberboard folded four times to make overlapping liner.

2. Place five-panel liner in 18-3/4-inch by 12-inch by 6-1/2-inch fiberboard tray and

place fiberboard tray with liner over face of unit.

3. Place six 14-inch by 19-inch fiberboard sheets on bottom of inner carton.

4. Place unit in inner carton.

5. Fabricate two fiberboard pads by taping three 14-inch by 3-1/2-inch fiberboard sheets for each pad.

6. Tape or staple each pad to another 14-inch by 13-inch fiberboard sheet along the 14-inch sides and the bottom edges.

7. Place two special pads made in step 5 on each side of the unit for blocking.

8. Fabricate a fiberboard saddle by folding fiberboard sheet several times near two opposite sides to form relatively rigid legs. The legs should be 2 inches deep and the overall dimensions of the saddle should be 9-1/2 inches by 13 inches.

9. Place fiberboard saddle in back of unit with legs against end of inner carton.

10. Secure one 9-1/4-inch by 6-inch fiberboard sheet to back of saddle with staples.

11. Fabricate a fiberboard pad by taping five 6-1/2-inch by 16-3/4-inch fiberboard sheets together.

12. Place fiberboard pad on back bar of unit and against fiberboard sheet attached to saddle. Secure pad to saddle with tape.

13. Place two 20-1/2-inch by 19-inch fiberboard sheets on top of unit.

14. Seal and mark inner carton to identify contents.

15. Insure that inner carton is rattle-free.

16. Line four sides and bottom of outer carton with 3-1/2-inch thick, bound-hair cushioning.

17. Insert inner carton into outer carton.

18. Place 3-1/2-inch thick, bound-hair cushioning on top of inner carton.

19. Seal and mark outer carton in accordance with local carrier's requirements.

20. Insure that outer carton is rattle-free.

B. PROCEDURE - 13

1. Insure that dust covers are protecting electrical connectors on back of unit.

NOTE: Refer to the table of packing materials and procedure reference for the number and size of fiberboard sheets required.

2. Place fiberboard sheets on bottom of inner carton.

3. Place fiberboard tray over front of unit between handles. The fiberboard tray should fit snugly between panel handles.

4. Place unit in inner carton.

NOTE: See size column of table for dimensions of fiberboard sheets.

5. Fabricate two fiberboard pads by taping several fiberboard sheets together.

6. Place one fiberboard pad on each side of unit to block out sides. The fiberboard pad shall be thick enough to insure that the unit fits snugly in the inner carton.

NOTE: Refer to table for the number and size of

fiberboard sheets required.

7. Place fiberboard sheets on top of unit.
8. Seal and mark inner carton to identify contents.
9. Insure that inner carton is rattle-free.

NOTE: Refer to table for thickness of cushioning material required.

10. Line four sides and bottom of outer carton with bound-hair cushioning.
11. Insert inner carton into outer carton.
12. Place bound-hair cushioning on top of inner carton.
13. Seal and mark outer carton in accordance with local carrier's requirements.
14. Insure that outer carton is rattle-free.

B. PROCEDURE - 14

1. Insure that dust covers are protecting electrical connectors on back of unit.
2. Fabricate fiberboard pad by taping eight 18-1/2-inch by 14-inch fiberboard sheets together.
3. Place fiberboard pad on bottom of inner carton, centering it.
4. Place unit on top of fiberboard pad so that the four feet of the unit are blocked out.
5. Fabricate two fiberboard pads by taping several 18-1/2-inch by 19-inch fiberboard sheets together.
6. Place one fiberboard pad on each side of unit.
7. Fabricate fiberboard saddle by folding fiberboard sheet several times near two opposite sides to form relatively rigid legs.
8. Place fiberboard saddle on front panel to block out handles of panel.
9. Place one 18-1/2-inch by 19-inch fiberboard sheet on top of unit.
10. Seal and mark inner carton to identify contents.
11. Insure that inner carton is rattle-free.
12. Line four sides and bottom of plywood box with 4-inch thick, bound-hair cushioning.
13. Place inner carton in plywood box.
14. Place 4-inch thick, bound-hair cushioning on top of inner carton.
15. Seal and mark outer box in accordance with local carrier requirements.
16. Insure that box is rattle-free.

B. PROCEDURE - 15

1. This unit will be shipped directly from the vendor. Repacking for shipment would be essentially the same as unpacking. No specific steps or materials are available at this time.

Chapter 3

SUPPORT EQUIPMENT

3-1 TOOLS

All tools required for checkout, maintenance, and repair of the optics-inertial test set are contained in the standard tool kit.

3-2 TEST EQUIPMENT

Table 3-1 lists test equipment required for checkout and calibration of the optics-inertial test set. Additional equipment for troubleshooting and repair of the optics-inertial test set is available at field sites.

Table 3-I. Standard Test Equipment

Name	Part Number	Range	Accuracy
Power supply (2 required)	Harrison Lab 808A	0 to 36 volts dc; 5 amps	Not applicable
Power supply	Trygon C36-50	0 to 36 volts dc; 50 amps	Not applicable
Audio oscillator	Hewlett Packard 200CD	5 cps to 600 kc; 0 to 10 volts	±2%; Distortion 0.5%
Audio oscillator	Hewlett Packard 201C	20 cps to 20 kc; 0 to 42.5 volts	±1%; Distortion 0.5%
Function generator	Hewlett Packard 202A	0 to 30 volts peak-to-peak; 0.008 to 1200 cps	±3%; Distortion 2%
Pulse generator	E-H Lab 130		
Autotransformer	General Radio W5MT3A	0 to 140 volts; 5 amps maximum	±3%
Isolation Transformer		1:1	
Transformer	1016104	115:66	±5%
Transformer	1016088	1:6.5 and 1:7	±5%
Vacuum tube voltmeter	Hewlett Packard 400H	1 mv to 300 volts ac	±1% of full scale from 50 cps to 500 kc
DC voltohmmeter	Hewlett Packard 412A	1 mv to 1000 volts;	±1% of full scale
		1 ohm to 100 megohms;	±5%
		1 μ amp to 1 amp	±2% of full scale

(cont)

Table 3-I. Standard Test Equipment (cont)

Name	Part Number	Range	Accuracy
Phase angle voltmeter (800-cps and 3200-cps filters)	Gertsch PAV-2	1 mv to 300 volts	±2% to 20 kc; ±4% to 50 kc; ±1° on phase angle dial
Differential voltmeter	John Fluke 803	10 mv to 500 volts ac and dc	±0.05% dc ±0.2% ac
Counter-Timer	Computer Measurement Corp. 727B	dc to 13 mc; 0.3 μ sec to 10^8 seconds	±1 count ±5 parts in 10^7
Spectrum analyzer	Hewlett Packard 302A	20 cps to 50 kc; 30 μ v to 300 volts	±5%
Servo analyzer	Temco 101		
Oscilloscope	Tektronix 545A	0.1 μ sec/cm to 12 sec/cm sweep range	Calibration of fixed sweep within 3%
Oscilloscope preamplifier	Tektronix CA (dual trace)	0.05 to 50 volts/cm	Vertical deflection factor within 3%
Decade resistance box (2 required)	Clarostat 240C	1 ohm to 1 megohm	±2%
Voltohmmeter	Simpson 269	1.6 to 4000 volts dc; 3 to 800 volts ac; 2 kilohms to 200 megohms; 16 μ amps to 16 amps	±3% of full scale ±5% of full scale ±3%

(cont)

Table 3-I. Standard Test Equipment (cont)

Name	Part Number	Range	Accuracy
Decade capacitance box	General Radio 1419B	100 μμ f to 1.1110 μf	±1.5%
Decade inductance box	General Radio 1490C	1 mh to 1.11 henry	±2%
Potentiometer		0-50,000 ohms	

Chapter 4

THEORY OF OPERATION

4-1 SCOPE

This chapter presents a functional description of the AC Spark Plug manufactured portions of the optics-inertial test set and a description of their interaction. Schematics and other detailed drawings have not been included, but are referenced by number. Where necessary, simplified diagrams of the data flow within the optics-inertial test set have been included.

4-2 GENERAL THEORY (To be supplied)

4-3 DETAILED THEORY

For detailed theory, the optics-inertial test set has been divided into individual panels and components. The panels covered in paragraphs 4-3.1 through 4-3.12 are located in the optics-inertial analyzer. The current source monitor panel is located in the AGE coolant and power console. The GSE junction box and PSA test point adapter are independent components, not mounted in any console. The oscillograph console contains no AC Spark Plug manufactured panels.

(To be supplied)

Figure 4-1. Optics-Inertial Test Set, Signal Flow Diagram

4-3.1 MONITOR PANEL. (Refer to figure 4-2.) The monitor panel indicates malfunctions, both in the airborne equipment and in the optics-inertial test set. The panel continually receives signals which are applied to detector circuits within the panel. When the signals are out of tolerance, the detector circuits cause the appropriate lamps on

the front of the panel to light. The panel also contains an audible alarm system operated by circuits contained in the temperature monitor and control panel.

4-3.2 TEMPERATURE MONITOR AND CONTROL PANEL. (Refer to figure 4-3.) This panel controls and monitors the temperature of the inertial components in the IMU. It can also be used to calibrate the airborne temperature control circuits. The audible alarm system in the monitor panel is operated whenever a temperature discrepancy is detected.

(To be supplied)

Figure 4-2. Monitor Panel, Signal Flow Diagram

(To be supplied)

Figure 4-3. Temperature Monitor and Control Panel, Signal Flow Diagram

4-3.3 POWER SUPPLY AND LOAD PANEL. This panel provides the airborne equipment with lamp power and standby ducosyn excitation, and provides the gimbal position control panel with motor drive voltage. In addition, the panel is used to monitor the running time of the airborne equipment, and provides simulated loads for the airborne circuits and power supplies. A simplified diagram of the signal flow is given in figure 4-4. The diagram and the following explanation are based on the panel schematic (1900738), the power supply schematics (1900341, 1900733), and the GSE power control and distribution mechanization diagram (1900144).

The ducosyn excitation power supply uses 115 volts, 60 cps from the ac power protection panel to produce an output of 2 volts, 3200 cps which, when not being sent to the IMU ducosyns, is fed to the simulated load consisting of R13 and R14. Whenever a malfunction in the airborne ducosyn circuit occurs, this output is sent to the IMU in place of the ducosyn excitation normally supplied by the PSA, and the normal ducosyn excitation is applied to the simulated load. Switching between the two sources of excitation is accomplished by two relays, K6 in the power supply and load panel and a GSE junction box relay. The outputs of both excitation sources are applied to both relays, which are always operated simultaneously.

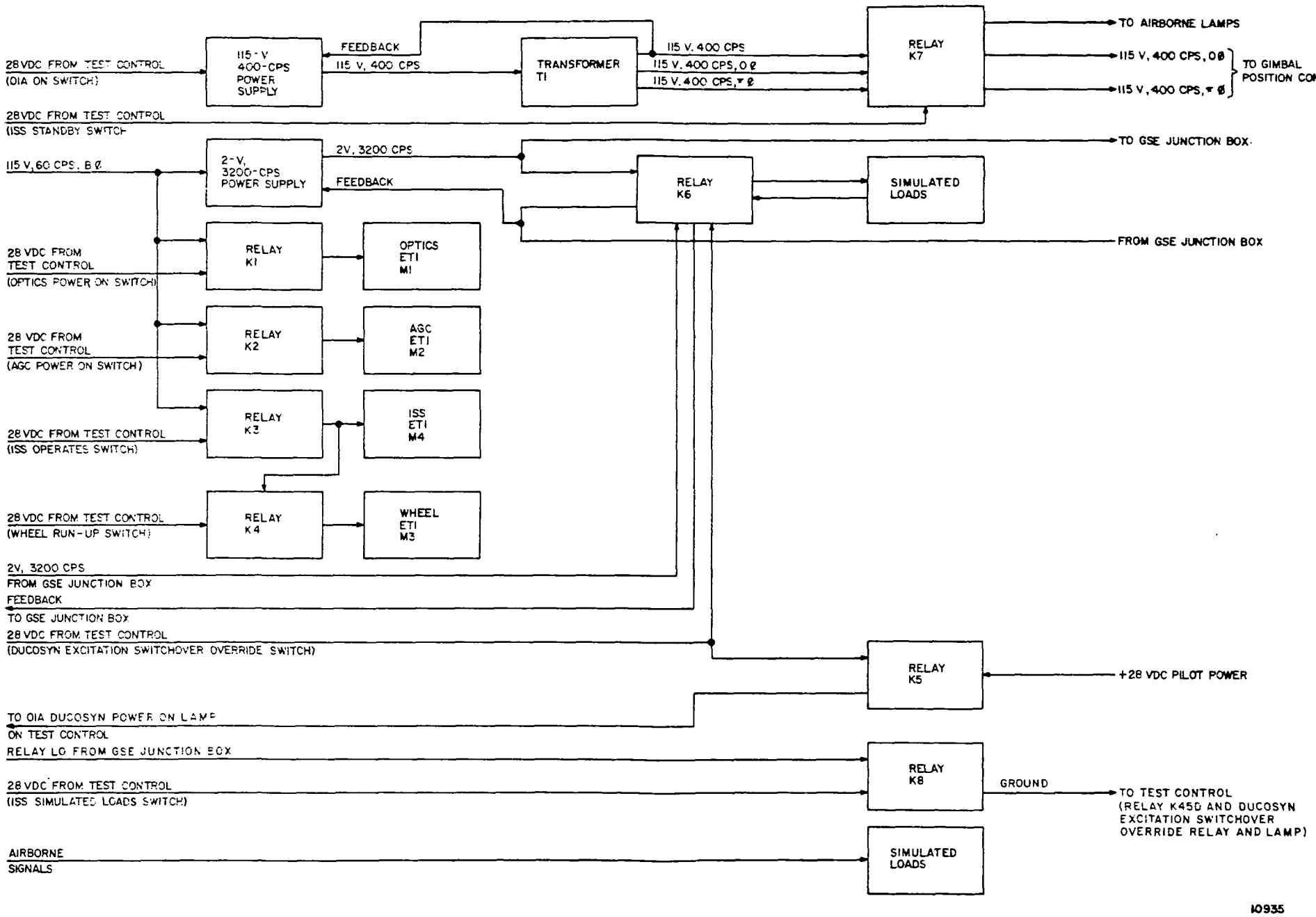


Figure 4-4. Power Supply and Load Panel, Signal Flow Diagram

When the relays are deenergized, excitation from the PSA is connected to the simulated load through relay K6, and the output of the ducosyn excitation power supply is sent to the IMU ducosyns through the GSE junction box relay. When the relays are energized, the excitation from the PSA is sent to the IMU ducosyns through the GSE junction box relays, while the ducosyn excitation power supply output is connected to the simulated load through relay K6. The simulated load and the IMU ducosyns each provide a feedback voltage used to regulate the output of the excitation source. During normal operation, the two relays are kept energized by 28 volts dc from the airborne ducosyn circuit; when a malfunction occurs in the airborne ducosyn circuit, the relays can be kept energized by 28 volts dc from the DUCOSYN EXCITATION SWITCHOVER OVERRIDE switch in the test control panel.

The lamp and motor drive power supply uses 28 volts dc, applied when the OIA ON switch on the test control panel is pressed, to produce 115 volts, 400 cps. The output is connected to transformer T1, which has two secondary windings. One secondary produces 115 volts, while the other produces 230 volts and is center-tapped. The output of the 115-volt secondary is sent through energized relay K7 to the airborne equipment, where it is applied to the sextant reticle lamp, the MODE lamps on the IMU control panel, and the GIMBAL LOCK lamp in the map and data viewer. This output is also fed back to the power supply for use in regulating the power supply output. The center tap of the 230-volt secondary is used as a common, so that 115 volts, zero phase and π phase are both produced. Relay K7, when energized, sends the zero and π phase outputs to the drive motors in the gimbal position control panel. Relay K7 is energized by 28 volts dc from the ISS STANDBY switch in the test control panel.

All contacts of relays K5 and K8 are open whenever they are energized. K5 is energized by 28 volts dc from the DUCOSYN EXCITATION SWITCHOVER OVERRIDE switch on the test control panel, and relay K8 by 28 volts dc from the ISS SIMULATED LOADS switch on the test control panel. Relay K5 connects 28 volts dc pilot power from the monitor panel to the ducosyn POWER ON lamp on the test control panel. Relay K8 provides a ground for the DUCOSYN EXCITATION SWITCHOVER OVERRIDE light and relay in the test control panel.

The elapsed time indicators are powered by 115 volts, 60 cps from the ac power protection panel, and applied through relays K1, K2, K3, and K4. Relays K1 and K2, when energized, apply the 115 volts to the OPTICS and AGC indicators, respectively. Relays K1 and K2 are energized by the OPTICS POWER ON and AGC POWER ON switches, respectively, on the test control panel. Relay K3, when energized by the ISS OPERATE switch on the test control panel, applies the 115 volts to the ISS indicator and to a contact on relay K4, which, when deenergized, applies it to the WHEEL indicator. The WHEEL indicator is stopped when relay K4 is energized by the WHEELS DISABLED switch on the test control panel.

4-3.4 GIMBAL POSITION CONTROL PANEL. This panel is used to position the IMU gimbals, either to their zero positions or to positions set into the panel. A simplified diagram of the signal flow is given in figure 4-5. The diagram and the following explanation are based on the panel schematic (1900455), the gimbal dump protection assembly schematic (1900176), the phase sensitive error detector schematic (1900319), the servo amplifier schematics (1900263, 1900361, 1900362), the gimbal position display electrical and gearing schematics (1900286, 1900395), and the test control mechanization diagram (1900258). The panel is divided into three separate but identically operating sections, one to position each gimbal. The following explanation is for the outer gimbal assembly; except for the reference designations; it also applies to the middle and inner gimbal assemblies.

The assembly operates in two basic modes, controlled by the MODE SELECT switch, S12. When S12 is in the FINE or FINE REPEAT position, the IMU gimbal is driven automatically to the nearest 16-speed resolver null position. When it is in the COARSE position, the IMU gimbal follows the values set into the gimbal position display, A9.

In the FINE and FINE REPEAT positions, the MODE SELECT switch energizes the mode selection relay, K32, which connects the sine output of the 16-speed IMU resolver to the input of the servo amplifier, AR1. The amplifier output is applied to the IMU torque motor to drive the gimbal until the sine output of the 16-speed IMU resolver is nulled.

When the MODE SELECT switch is in the COARSE position, K32 is deenergized, connecting the sine and cosine outputs of the 16-speed IMU resolver to the 16-speed resolver in the panel. The resultant error signal is sent through deenergized K32 to amplifier AR1 and then to the IMU torque motor. Both resolvers and the counter in the assembly are driven by the manual thumbwheel or gimbal position display motor, which receives a 115-volt, 400-cps signal of either zero or pi phase through the SLEW switches, S8 and S9, the error detector relay, K24, and the gimbal dump relay, K16.

4-3.4.1 Phase Sensitive Error Detector Function. Before the IMU gimbal can be positioned to the angle set into the panel, the IMU gimbal must be within three degrees of the position displayed on the panel. To accomplish this, a one-speed servo loop is set up using the phase sensitive error detector, A2.

The sine and cosine outputs of the one-speed IMU resolver are connected to the one-speed resolver in the panel, and the resultant error signal is applied to the error detector. Whenever the error is less than three degrees, the error detector is deenergized, and the gimbal display motor is driven by the SLEW switch voltage. When the error is above three degrees, however, a circuit within the error detector deenergizes error detector relay K24 and energizes gimbal dump relay K16. Operation of these relays switches control of the gimbal display motor from the SLEW switches to the error detector. The error detector supplies 115 volts, 400 cps, of whichever phase is required to drive the gimbal display motor and the one-speed panel resolver until it matches the position of the one-speed IMU resolver.

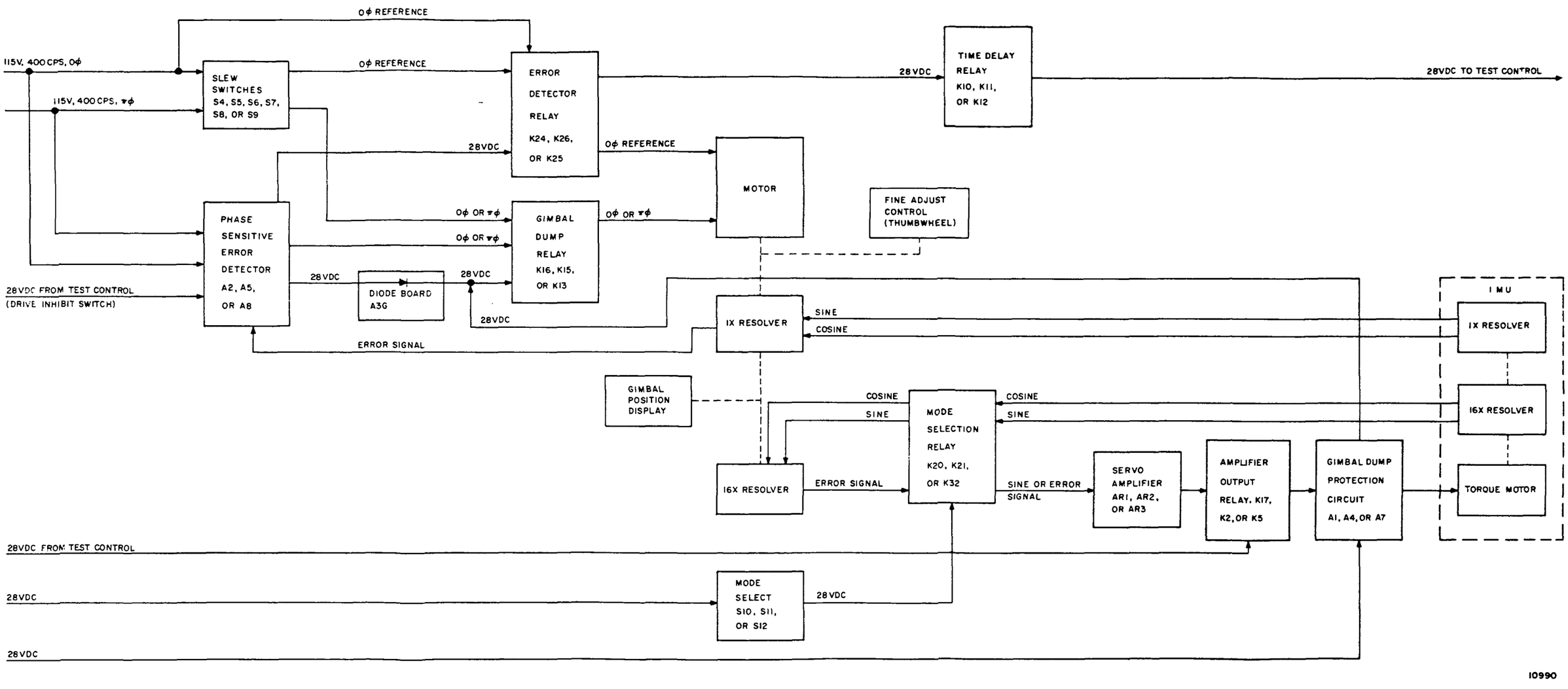


Figure 4-5. Gimbal Position Control Panel, Signal Flow Diagram

When the panel resolver has been driven to within three degrees of the IMU resolver, the error detector sends 28 volts dc through error detector relay K24 to time delay relay K12. After two seconds, K12 sends the 28 volts dc to the test control panel, which returns it, together with a latching voltage for K12, to amplifier output relay K17, closing the 16-speed servo loop to restore normal operation.

4-3.4.2 Gimbal Dump Protection Circuit Function. Whenever the output of servo amplifier AR1 drives the outer gimbal at a rate below seven radians per second, the gimbal dump circuit, A1, is inactive and couples the amplifier output to the IMU torque motor. When the amplifier output drives the outer gimbal at a rate above seven radians per second, a relay within the gimbal dump circuit opens the amplifier output circuit. The gimbal dump circuit must be reset by a signal from the gimbal dump reset switches in the test control panel.

4-3.5 TEST CONTROL PANEL. (Refer to figure 4-6.) This panel is used to select the normal functional modes of the airborne equipment and to control the application of power to the optics-inertial analyzer and to the airborne equipment. For the specific function of each control, refer to figure 1-6. The schematic is 1900649 and the test control mechanization diagram is 1900258.

(To be supplied)

Figure 4-6. Test Control Panel, Signal Flow Diagram

4-3.6 TEST SELECTOR PANEL. (Refer to figure 4-7.) This panel selects the test to be performed after the correct functional mode has been established using the test control panel. The CDU's, gimbal servos, IRIG's, and optics mechanism can be tested in this way. The panel is also able to partially check out the monitor panel detector circuits and the optics-inertial analyzer's alarm system. A continuity check of certain portions of the airborne equipment can also be performed. For the specific functions of each control and indicator on the panel, refer to figure 1-7. The panel schematic is 1900692; the test control mechanization diagram is 1900258.

(To be supplied)

Figure 4-7. Test Selector Panel, Signal Flow Diagram

4-3.7 PHASE SHIFT PANEL. A block diagram of the signal flow through this panel is shown in figure 4-8. The diagram and the following explanation are based on the panel schematic (1900431).

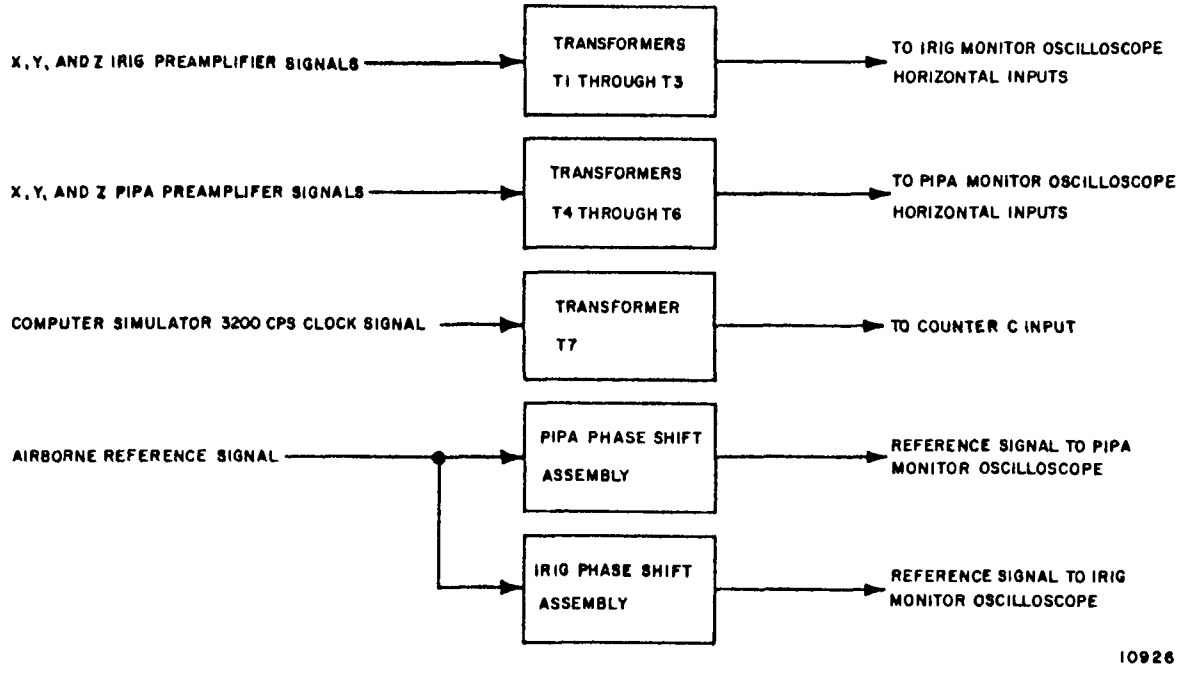


Figure 4-8. Phase Shift Panel, Signal Flow Diagram

Transformers T1 through T6 have no phase shift; they are used as buffers between the IRIG and PIPA preamplifier outputs and the two, four-channel oscilloscopes on which the IRIG and PIPA signals are continuously monitored. The IRIG and PIPA signals are applied to the oscilloscope horizontal inputs, while airborne reference signals, phase-shifted by the PIPA and IRIG phase shift assemblies, are applied to the vertical inputs to produce Lissajous patterns. These patterns indicate the state of suspension of the IRIG's and PIPA's.

Transformer T7 has no phase shift and is used as a buffer between the computer simulator and the C input of the counter.

4-3.8 DIGITAL RECORDER PANEL. This panel can provide a printed record of readings made by the counter, the digital voltmeter, or the computer test set. The panel consists of a commercial printer and 16 signal selection relays. A simplified diagram of the signal flow involved in the signal selection is given in figure 4-9. The simplified diagram and the following explanation are based on the panel schematic (1900242) and the AGE-GSE signal selection mechanization diagram (1900066).

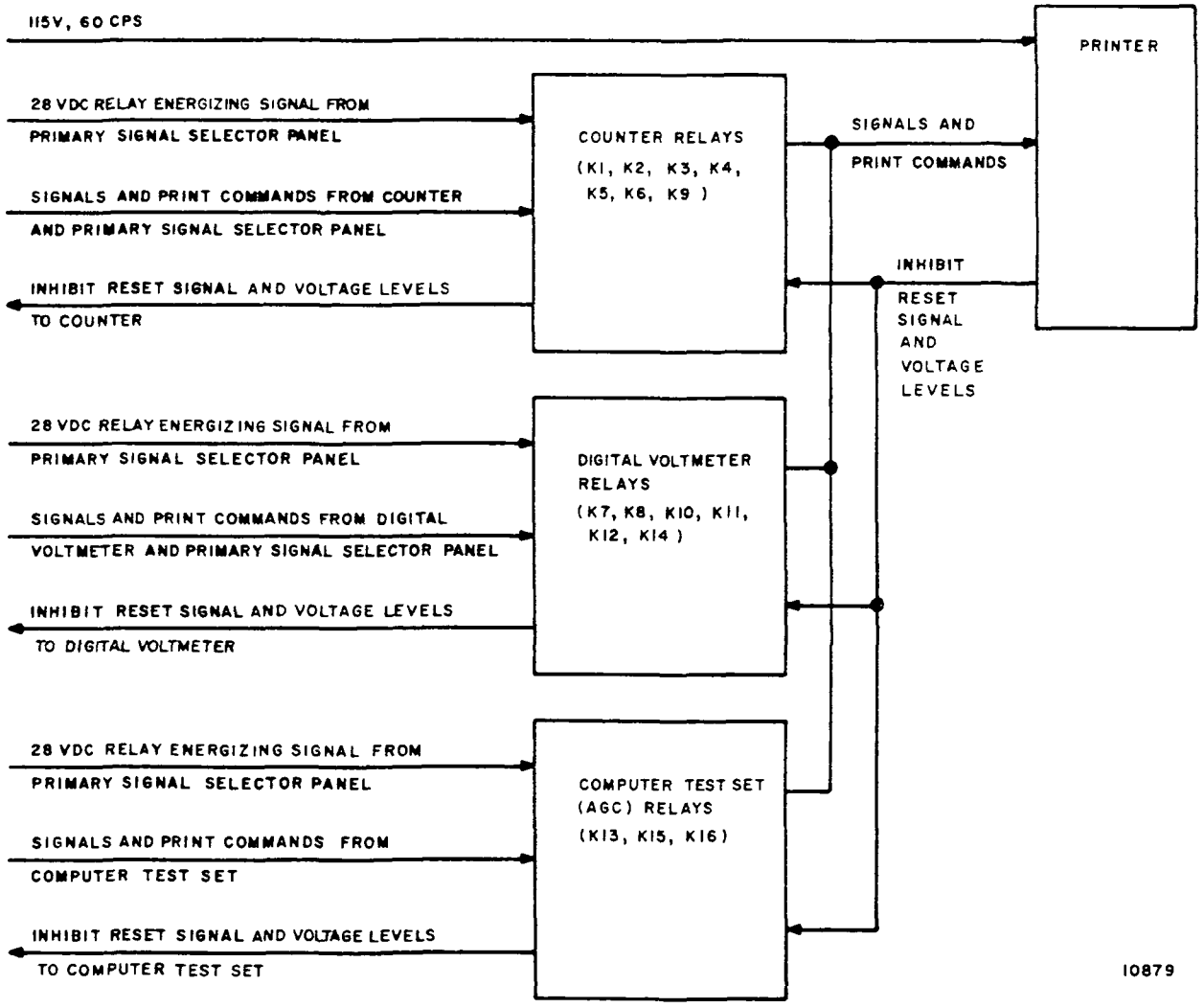


Figure 4-9. Digital Recorder Panel, Signal Flow Diagram

The signal selection relays are divided into three groups as shown in figure 4-9. Each group, when energized, connects a different set of signals to the printer, with only one group being energized at any one time. One set of signals contains counter information; the second contains digital voltmeter information, and the third contains computer test set information. The 28-volt dc energizing signal is applied to the selected group of relays by the DIGITAL RECORDER SELECTOR in the primary signal selector panel.

The printer, capable of printing up to three, 12-column lines per second, receives signals and print commands directly from the monitoring device whose outputs are to be recorded. The print commands are generated by the monitoring device, but signals containing the information to be printed are developed by the monitoring devices using voltage levels (binary one and binary zero) supplied by the printer. To assure that the value being received from the monitoring device does not change during the time it is being recorded, the printer, upon receipt of a print command, transmits an inhibit reset signal which freezes the existing output on the monitoring device until the printing of that output is completed.

When the counter relays are energized, all 12 columns of the printer are utilized. Columns 1 through 7 record the number and polarity symbol currently being read out on the counter. Column 8 records the counter function as selected by the counter's INPUT SELECTOR and FUNCTION switches. Columns 9 through 12 record the position of the counter input select switches on the primary signal selector panel; these positions identify the source of the counter input.

When the digital voltmeter relays are energized, all columns except 1, 6, and 9 are normally used. Those three columns receive suppression signals that prevent their printing any number. Columns 2, 3, 4, 5, and 7 record the number and symbol currently being read out on the digital voltmeter, and column 8 prints a code number which represents the position of the decimal point. Except when an auxiliary signal is being applied to the digital voltmeter input, columns 10 and 11 record the position of the crossbar switch, and column 12 records the position of the DVM switch on the primary signal selector panel. Those switch positions identify the source of the digital voltmeter input. However, when the DVM switch is set to the auxiliary (AUX) position, a suppression signal is sent to columns 10, 11, and 12.

When the computer test set (AGC) group of relays is energized, only columns 1 through 6 are utilized. The computer test set sends suppression signals to columns 7 through 12.

4-3.9 PRIMARY SIGNAL SELECTOR PANEL. The two major functions of this panel are control of the crossbar switch position and selection of counter inputs. In addition, it contains switches to select inputs to oscilloscope A, the digital and phase angle voltmeters, and the digital recorder. A simplified diagram of the signal flow involved in the two major functions is given in figure 4-10. The simplified diagram and the following

explanation are based on the panel schematic (1900498), the GSE counter signal select mechanization diagram (1900077), and the AGE-GSE signal selection mechanization diagram (1900066).

4-3.9.1 Counter Input Selection. Signals applied to channels A and B of the counter are counted, while signals applied to channel D start and stop counter operation. There are two types of signals sent to the counter through this panel: command and data pulses and sine wave reference signals. The pulses are applied to all three channels, while the reference signals are applied only to channel D. All pulses representing positive drives are connected to channel A through section A of "A" OR "AB" switch A1S1, and all pulses representing negative drives are connected to channel B through section B of the same switch. Both sets of torquing pulses are, in addition, connected through decoupling diodes to section A of "D" PULSE switch A2S1. This switch connects the pulses to relay A5K1, which also receives the reference signals through section A of "D" SIGNAL switch A3S1. This relay, operated by 28 volts dc from D SIGNAL--D PULSE switch S10, selects either the pulses or the reference signals and sends the selected signal to channel D of the counter. The manner in which these signals are utilized is determined by switch settings on the counter.

The B sections of "D" SIGNAL and "D" PULSE switches and the C section of "A" OR "AB" switch send signals to columns 9, 10, 11, and 12 of the digital recorder. The positions of "A" OR "AB" switch are printed out as numbers 1 through 23 in printer columns 11 and 12. The "D" PULSE and "D" SIGNAL switch positions are recorded in columns 9 and 10. The D SIGNAL--D PULSE switch determines which of the two switches will have its position recorded. The "D" PULSE switch positions are printed as numbers 1 through 23, while the "D" SIGNAL switch positions are printed as numbers 31 through 45.

When the computer simulator is being used as the source of the airborne motor drive signals, REMOTE C/S ENABLE switch S9 and C/S START switch S12 are involved in counter operation. Pressing these switches pulls in and latches relay A5K32. Closing of this relay starts computer simulator operation by removing the 13-volt dc inhibit voltage from the simulator. When the counter reaches the end of its counting period, it sends a signal to relay A5K32 through transformer A5A1T3. This signal causes the relay to unlatch and stop simulator operation by reapplying the inhibit voltage. To meet an IRIG requirement requiring the last pulse applied to the IRIG must be positive, capacitor A5A1C2 is used. At the same time that the inhibit voltage is removed from the computer simulator, it is applied to this capacitor. When relay A5K32 unlatches at the end of the count period, the capacitor discharges into the computer simulator. This discharge causes the simulator to produce four final pulses--two negative followed by two positive--following the reapplication of the inhibit voltage. The CTR RESET switch, S13, allows manual reset to relay A5K32.

4-3.9.2 Crossbar Switch Control. When power is first applied to the crossbar switch control circuit by pressing POWER ON switch S4, the crossbar switch will go to the position indicated by TENS switch S7 and UNITS switch S6. The following sequence is

involved in this operation. The 28 volts dc from the POWER ON switch goes through normally closed PUSH TO ADVANCE switch S5 to energize relay A5K29. This relay then sends the 28 volts dc through the contacts of deenergized relay A5K30 to the TENS switch. The TENS switch routes the 28 volts dc to the appropriate tens coil in the crossbar switch. The coil, when energized, receives 28 volts dc directly from relay A5K29 and uses it as a holding voltage. At the same time, the coil returns an interlock signal to energize relay A5K30, thus cutting off any further power through the TENS switch. The energized A5K30 in turn energizes A5K28. The 28 volts dc from the PUSH TO ADVANCE switch then passes through energized A5K28 and deenergized A5K31 to the UNITS switch. The UNITS switch routes the 28 volts dc to the appropriate units coil in the crossbar switch. The coil, when energized, receives 28 volts dc directly from A5K28 and uses it as a holding voltage. At the same time, the coil returns an interlock signal to energize A5K31, cutting off any further power through the UNITS switch. The crossbar switch will remain in the existing position, regardless of the setting of the TENS and UNITS switches, until the PUSH TO ADVANCE switch is pressed, deenergizing the four relays and restarting the above sequence.

The hold voltages are coupled back from the crossbar switch coils to energize relays A5K9 through A5K26. These relays connect signals to the digital recorder so that the position of the crossbar switch is recorded. The units number is printed in column ten, the tens number in column 11. The hold voltages also light a series of lamps which illuminate the appropriate numbers in the CROSSBAR CONTROL digital readout.

4-3.9.3 Digital Recorder Control. DIGITAL RECORDER SELECTOR S11 sends 28 volts dc to the digital recorder panel, where it is used to energize relays which select the inputs applied to the printer. (See paragraph 4-3.8.)

4-3.9.4 Voltmeter and Oscilloscope Inputs. DVM switch S2, PAVM switch S8, and SCOPE "A" INPUT SIGNAL switch S1 each select the input to be monitored on their respective monitoring device. Each can select either of two outputs (signal one and signal two) from the crossbar switch or an auxiliary signal. SCOPE "A" INPUT REFERENCE switch S3 selects any one of six reference signals from the oscillograph signal selector panel. (See paragraph 4-3.11.)

4-3.10 COAXIAL DISTRIBUTION PANEL. This panel is used primarily to provide switching for signals which would be distorted if sent through a normal switch. A simplified diagram of the signal flow through the panel is given in figure 4-11. The simplified diagram and the following explanation are based on the panel schematic (1900266) and the AGE-GSE signal selection mechanization diagram (1900066).

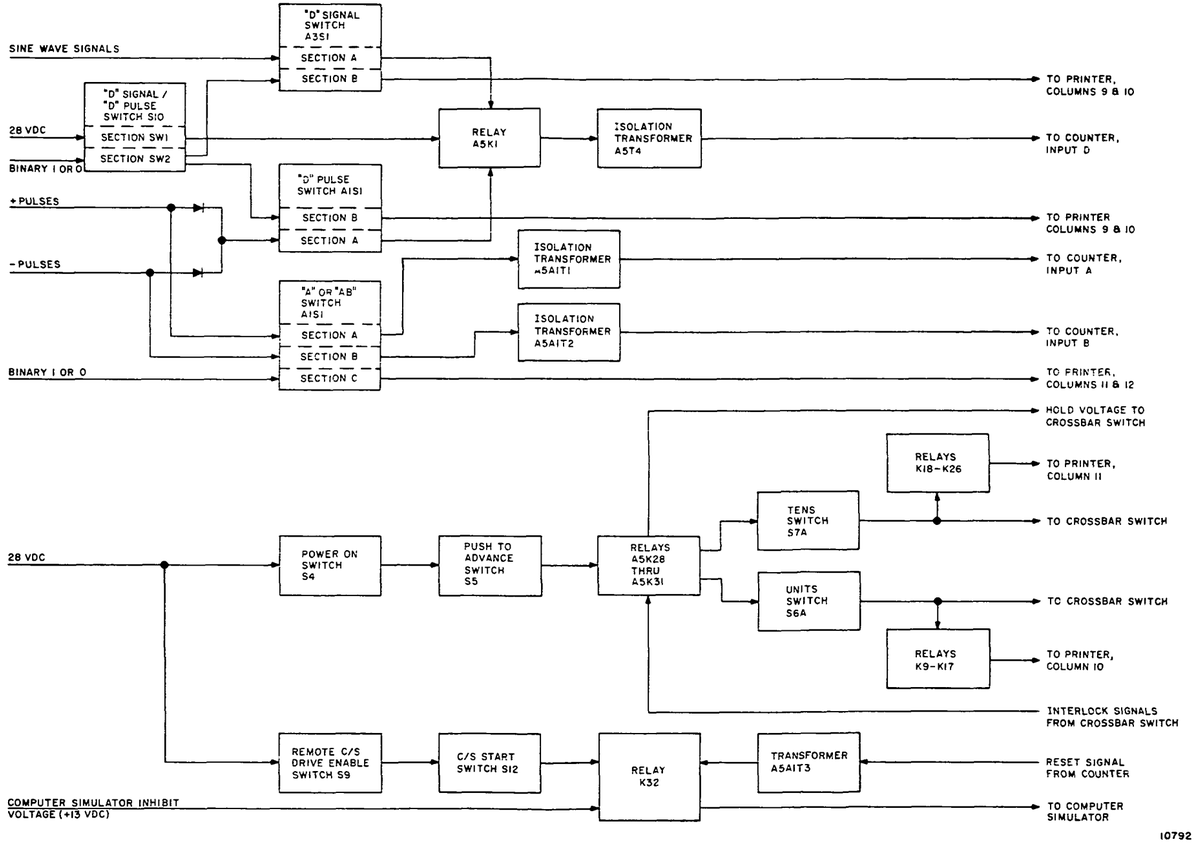


Figure 4-10. Primary Signal Selector Panel, Signal Flow Diagram

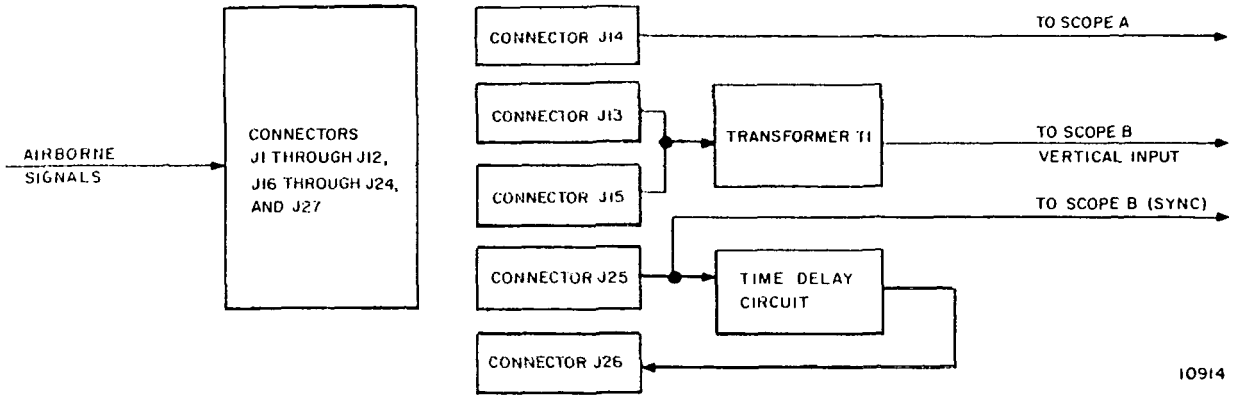


Figure 4-11. Coaxial Distribution Panel, Signal Flow Diagram

The incoming signals from the distribution bay are fed directly to the front panel input connectors, J1 through J12, J16 through J24, and J27. There are three output connectors, J13, J14, and J15, and two time delay connectors, J25 (input) and J26 (output). Short coaxial jumpers are used to make all connections. Any of the input connectors may be connected to any of the output connectors or to the time delay input connector. The time delay output connector can be jumpered to output connector J13 or J15.

The input signal jumpered to connector J14 is sent through the SCOPE "A" INPUT SIGNAL switch on the primary signal selector panel to the scope A portion of the dual beam oscilloscope. Connectors J13 and J15 are tied together internally and are connected to isolation transformer T1. The output of T1 is sent directly to input 1 of the scope B portion of the dual beam oscilloscope.

When the time delay circuit is being used, it is connected between the selected input connector and output connector J13 or J15. The undelayed input to the time delay circuit is also sent directly to the trigger input of the scope B portion of the dual beam oscilloscope. The delayed output is then jumpered to output connector J13 or J15. In this way, the trigger signal arrives approximately 0.3 microsecond in advance of the signal to be monitored, allowing pulses of short duration to be displayed in their entirety.

4-3.11 OSCILLOGRAPH SIGNAL SELECTOR PANEL. This panel performs two functions. It selects the signals to be monitored in the oscillograph console, and it provides reference signals for use in the oscillograph console, phase angle voltmeter, dual beam oscilloscope, and monitor oscilloscope. A simplified diagram of the signal flow involved in these two functions is given in figure 4-12. The diagram and the following explanation are

based on the panel schematic (1900648), the amplifier schematics (1900128, 1900129, 1900130, 1900131), and the GSE signal selection mechanization diagram (1900066).

4-3.11.1 Signals To Be Monitored. The signals to be monitored are received from the airborne equipment and are connected to the B and C decks of the eight CHANNEL SELECTORS (A1S1 through A8S1). The ac signals are applied to the channel one through six C decks, while the dc signals are applied to the channel three through eight B decks. The channel one and two B decks and the channel seven and eight C decks are not used.

The B and C deck commons of all eight CHANNEL SELECTORS are connected to the oscillograph console through the signal select relays (K17 through K24), but only the signal select relays for channels three through six can be controlled. Those four relays are controlled by the four AC-DC switches (S1, S2, S4, S5), which can apply 28 volts dc to the corresponding channel in the oscillograph console, switching that channel from an ac to a dc capability. A circuit in the oscillograph console then provides a ground to energize the associated signal select relay. The signal select relays in channels one and two are always deenergized, and those in channels seven and eight are always energized.

The ac outputs of the CHANNEL SELECTORS are also connected to the SCOPE B INPUT 2 switch, so that any ac signal being sent to the oscillograph console can also be monitored on input 2 of the scope B portion of the dual beam oscilloscope.

The A decks of the CHANNEL SELECTORS are used in selecting the reference signals sent to the oscillograph console.

4-3.11.2 Reference Signals. The five isolation amplifiers in the panel isolate three reference signals--800 and 3200 cps from the ISS and 800 cps from the OSS--from the airborne equipment for use in the optics-inertial test set. The 800-cps signals are each fed through two of the isolation amplifiers, one imparting no phase shift, the other imparting a 90-degree phase shift. The 3200-cps signal is fed through only a zero phase shift amplifier. The five outputs are distributed as shown in the data flow diagram.

The reference signal sent to the oscillograph console is determined by REFERENCE switch S3 and eight pairs of relays, K1 through K16. Switch S3 selects either the two zero phase or the two 90-degree phase signals. Each pair of relays, operated by 28 volts dc from the associated CHANNEL SELECTOR, selects one of its three inputs to be sent to the oscillograph console.

The three zero phase signals are sent directly to the phase angle voltmeter.

The reference signal sent to the scope B portion of the dual beam oscilloscope is selected by CHANNEL B REF switch S7 and TO PH GEN switch S6. Switch S6 selects an 800-cps signal from either the OSS or ISS and sends it to the 800-cps phase generator.

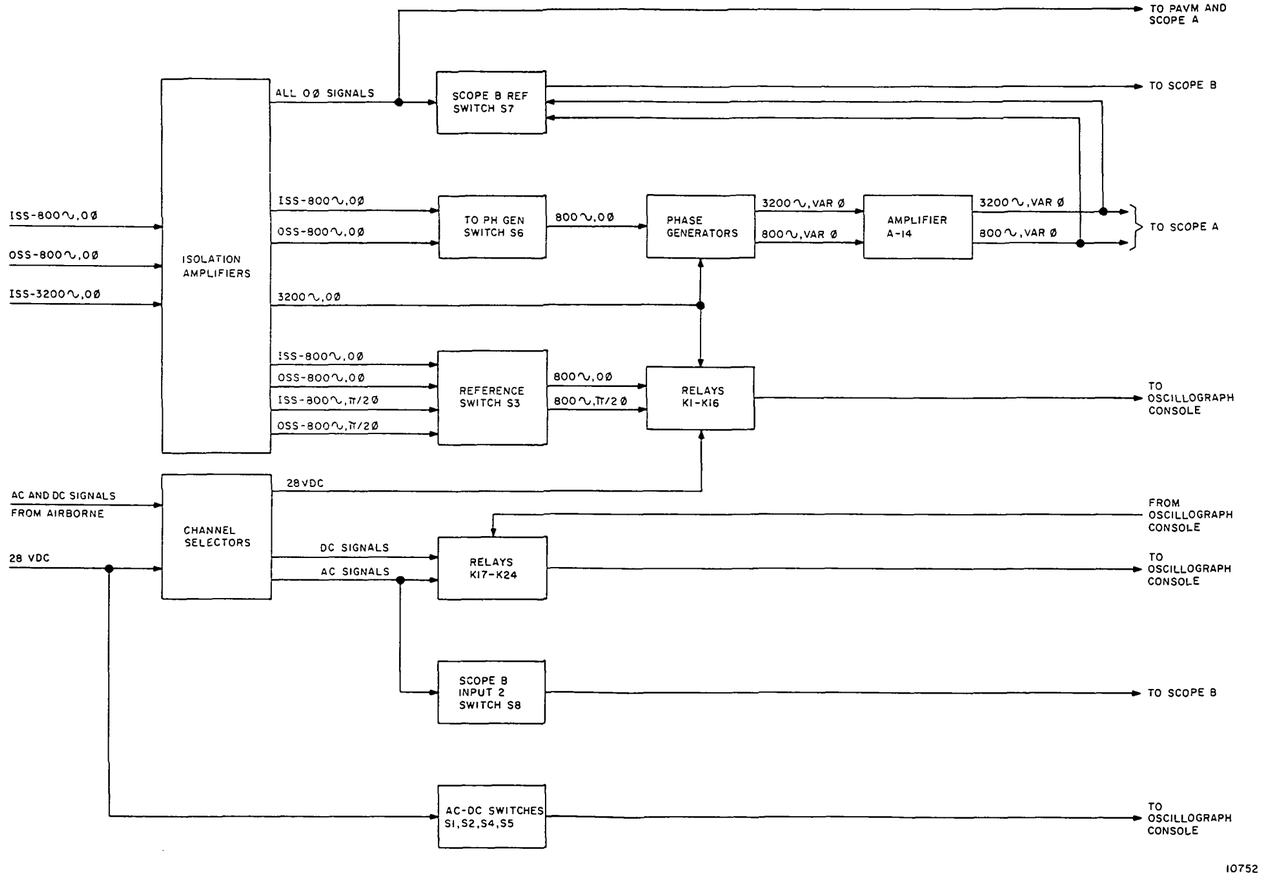


Figure 4-12. Oscillograph Signal Selector Panel, Signal Flow Diagram

The 3200-cps phase generator receives its input directly from the 3200-cps isolation amplifier. The phase generator outputs, variable from 0 to 360 degrees, are fed through amplifier A14 and applied to switch S7 together with three zero phase signals received directly from the isolation amplifiers.

The signals applied to switch S7 are also sent to oscilloscope A through a similar switch located in the primary signal selector panel.

4-3.12 AC POWER PROTECTION PANEL. The following explanation is based on the panel schematic (1900397). The 115-volt, 60-cps, 3-phase power for the optics-inertial analyzer is received through this panel. After passing through circuit breakers and filters, phase A and phase C are connected to the optics-inertial analyzer circuits through relay K1, which is energized by the OIA ON switch in the test control panel. The phase B power, after passing through the circuit breaker and filter, is connected to the coolant and power console through relay K2. This relay is energized by the AGE POWER switch in the test control.

In addition, a portion of the phase B power is bypassed by the circuit breaker, filtered and sent directly to the power supply and load panel, the monitor panel, and the coolant and power console. In those places, it powers circuits which must remain in operation at all times.

4-3.13 CURRENT SOURCE MONITOR PANEL. This panel, located in the AGE coolant and power console, is used in conjunction with the galvanometer to measure the output of the precision voltage reference modules in the PSA. To do this, the panel produces a precisely controlled, variable dc voltage which is compared to the PSA module output, using the galvanometer.

The panel contains a power supply, a 12-volt precision voltage regulator, a voltage divider network, and six one-volt, unsaturated standard cells. The panel operates in four modes:

(1) Voltage measurement

(2) Calibration

(3) Temperature measurement

(4) Standardization

The simplified diagrams presented in the following paragraphs are based on the panel schematic (1900083).

4-3.13.1 Voltage Measurement. (Refer to figure 4-13.) To produce the required precision voltage, the output of the precision voltage regulator is applied across the voltage divider, which consists of dropping resistor R10, ratio set A5, and calibration resistors R11 through R28. VOLTAGE RANGE switch S1 selects the output from the ratio set by connecting VOLTAGE control R36 across ratio set resistor R7 (0.9 to 1.5 volt ranges) or R9 (5 to 7 volt ranges) and by connecting the positive side of ratio set resistor R6, R5, R4, R3, R2, or R1 to the positive output of the panel. (Figure 4-13 shows the VOLTAGE RANGE switch set to 1.2-1.3.) Vernier control is provided by the VOLTAGE control, the output of which is connected to the negative output of the panel. Connections to the galvanometer and PSA module are made by SELECTOR switch S2.

To balance out the loading effects of the VOLTAGE control, a resistor of equal value (R35) is connected across R9 on the 0.9 to 1.5 volt ranges and across R7 on the 5 to 7 volt ranges.

4-3.13.2 Standardization. (Refer to figure 4-14.) Standardization is performed before every series of voltage measurements. OPERATE-CAL switch S3 is left in the OPERATE position, and the SELECTOR switch is set to STANDARDIZE. In this mode, the standard cells are substituted for the PSA module, and a preset precision potentiometer (R33 or R30, depending on the RANGE switch setting) is substituted for the VOLTAGE control. Any small changes in the output of the precision voltage regulator can be corrected by use of STANDARDIZE control R27, which effects minor changes in the amount of voltage across dropping resistor R10.

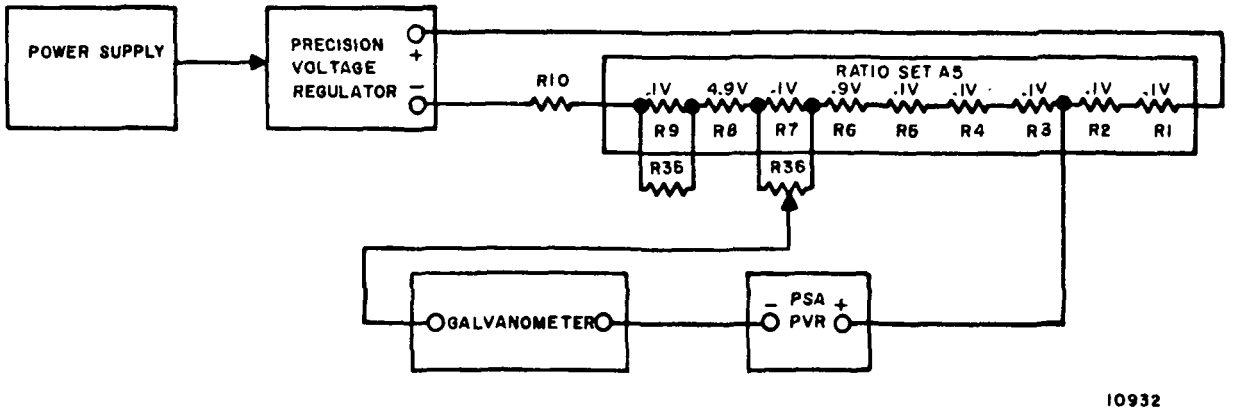


Figure 4-13. Voltage Measurement, Simplified Schematic Diagram

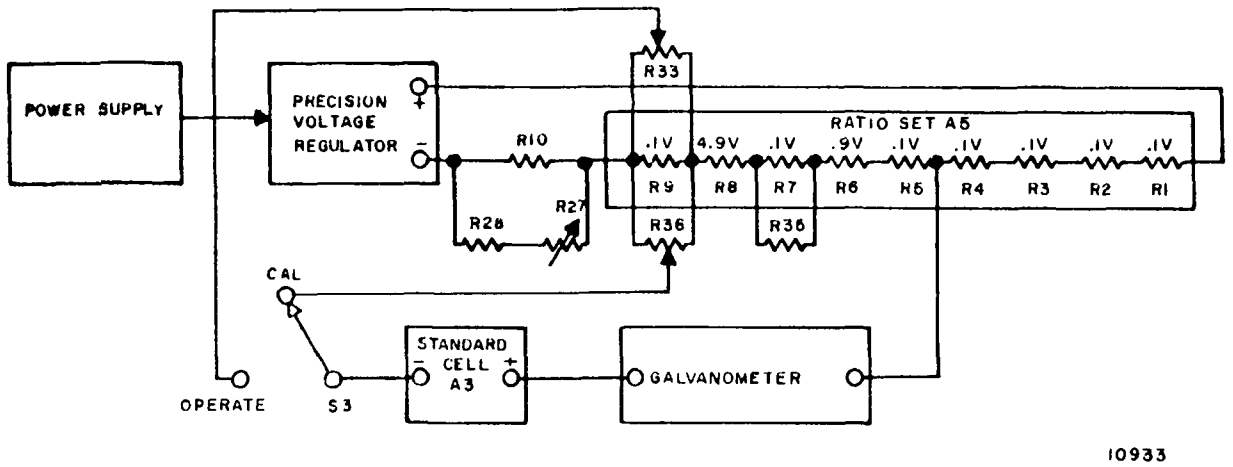


Figure 4-14. Standardization and Calibration, Simplified Schematic Diagram

4-3.13.3 Calibration. (Refer to figure 4-14.) Calibration is performed whenever the output of the standard cells has been found to change. The OPERATE-CAL switch is set to CAL, and the SELECTOR switch is set to STANDARDIZE. In this mode, the standard cell is substituted for the PSA module, and the VOLTAGE control is set to the known value of the standard cell. Any discrepancy is corrected by the STANDARDIZE control.

Following correction of the voltage divider output by the STANDARDIZE control, the OPERATE-CAL switch is set to OPERATE, which places the panel circuits in the same configuration as when in the standardize mode of operation. During calibration, however, the precision potentiometers (R33 and R30) are set to be compatible with the new value of the standard cells.

4-3.13.4 Temperature Measurement. (Refer to figure 4-15.) The temperature of the standard cells must be checked before every series of voltage measurements. The RANGE switch is set to the TEMPERATURE position. In this mode of operation, neither the voltage regulator nor the voltage divider is used. Instead, a portion of the power supply output is applied to a bridge circuit consisting of the VOLTAGE control, precision resistor R37, and temperature sensitive resistor R38, located within the thermo container of the standard cells. The output of the bridge is applied to the galvanometer; a null is achieved by adjustment of the VOLTAGE control. Settings of the VOLTAGE control correspond to specific temperatures of R38.

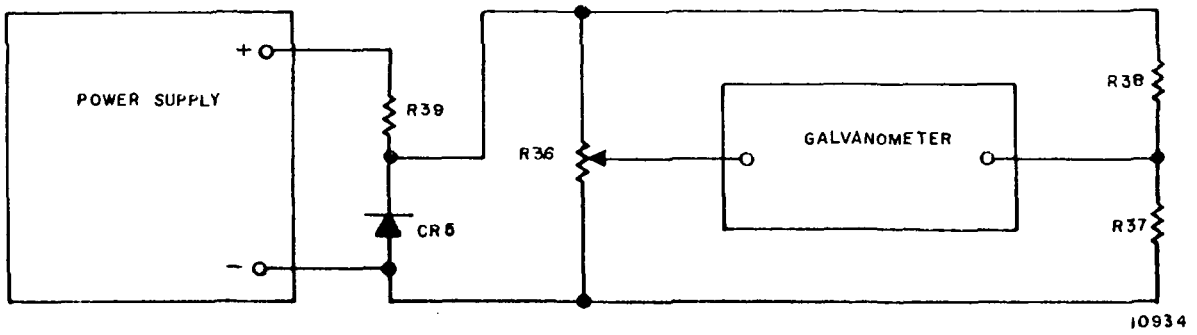


Figure 4-15. Temperature Check, Simplified Schematic Diagram

4-3.14 GSE JUNCTION BOX. (To be supplied)

4-3.15 PSA TEST POINT ADAPTER. (To be supplied)

Chapter 5

DESCRIPTION OF SYSTEM TIE-IN

5-1 SCOPE

This chapter lists the GSE components used in conjunction with the optics-inertial test set and illustrates how the optics-inertial test set functionally ties into these components and the airborne equipment during system and subsystem tests.

5-2 GSE COMPONENTS

During one or more of the airborne equipment tests, the following components are used in conjunction with the optics-inertial test set. A functional description of each component can be found in the checkout, maintenance, and repair manuals listed.

a. Apollo Guidance Computer simulator, 1014061 (ND 1021003)

b. Degausser, 1900299 (ND 1021034)

c. Remote optics controller, 1900491 (ND 1021034)

d. GSE-PSA junction box, 1900268 (ND 1021034)

e. AGC test set, 1020002 (ND 1021000)

f. Filling and purging fixture, 1900803 (ND 1021034)

g. IMU shipping bellows, 1900802 (ND 1021034)

h. AGC calibration console, 1014217 (ND 1021002)

i. Load and signal simulator set, 1900797 (ND 1021034)

j. IMU pressure seal tester, 1900804 (ND 1021034)

k. G and N mounting fixture, 1900014 (ND 1021034)

l. Optics navigation base mounting fixture, 1900013 (ND 1021034)

m. IMU mounting fixture, 1900012 (ND 1021034)

n. PSA mounting fixture, 1900606 (ND 1021034)

o. IMU fixture alignment bar set, 1900800 (ND 1021034)

p. Rotary table, 1900006 (ND 1021034)

q. Miscellaneous optical subsystem ground support equipment (ND 1021066)

r. Inertial components temperature controller, 1900342 (ND 1021034)

5-3 TIE-IN DURING SYSTEM AND SUBSYSTEM TESTING

Figures 5-1, 5-2, and 5-3 are block diagrams illustrating the data and power flow which occurs when the optics-inertial test set is incorporated into the GSE test stations. Figures 5-1 and 5-2 represent the configurations used in testing the inertial and optical subsystems, respectively, while the configuration used during G and N system testing is represented by figure 5-3. Procedures for establishing these configurations are contained in the G and N system checkout, maintenance, and repair manual (ND 1021036).

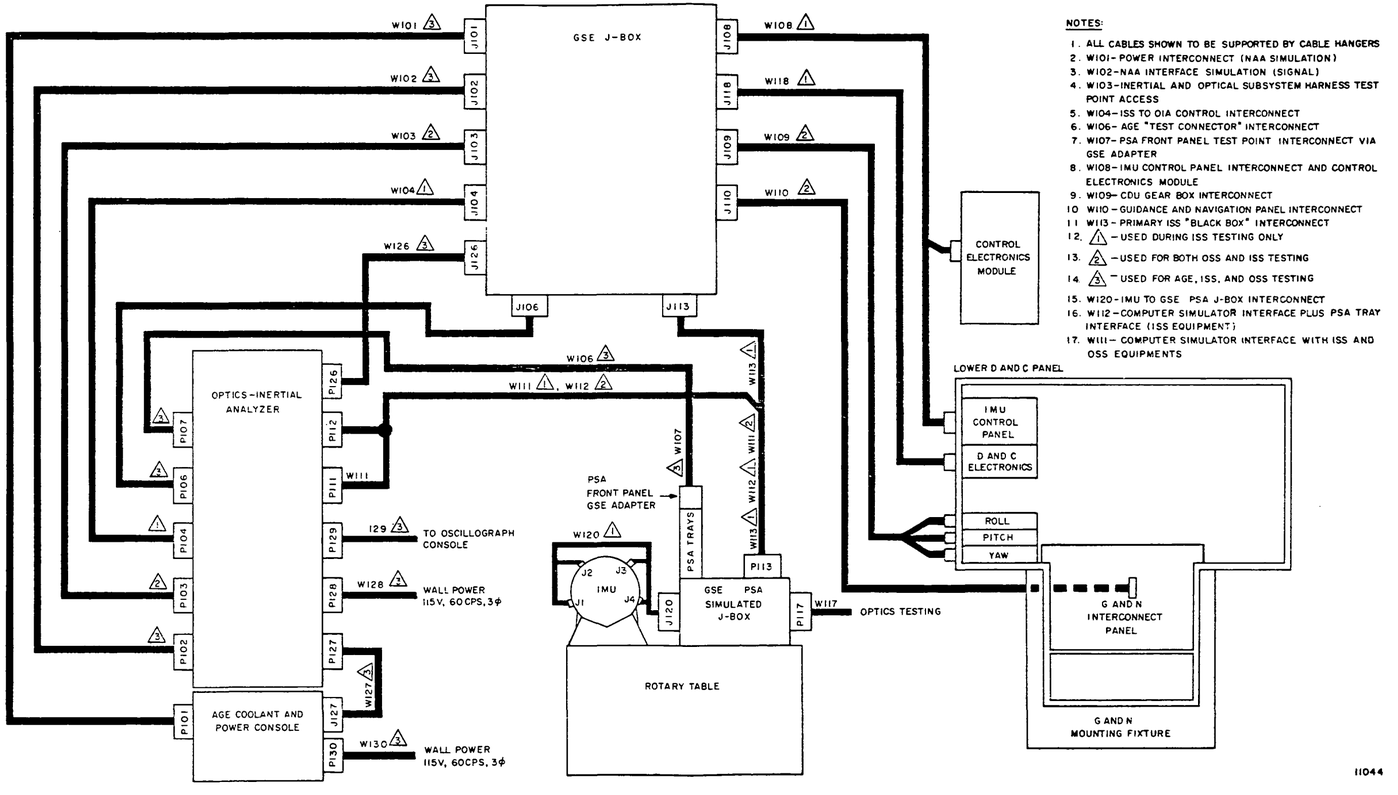


Figure 5-1. Optics-Inertial Test Set Tie-In During Inertial Subsystem Testing

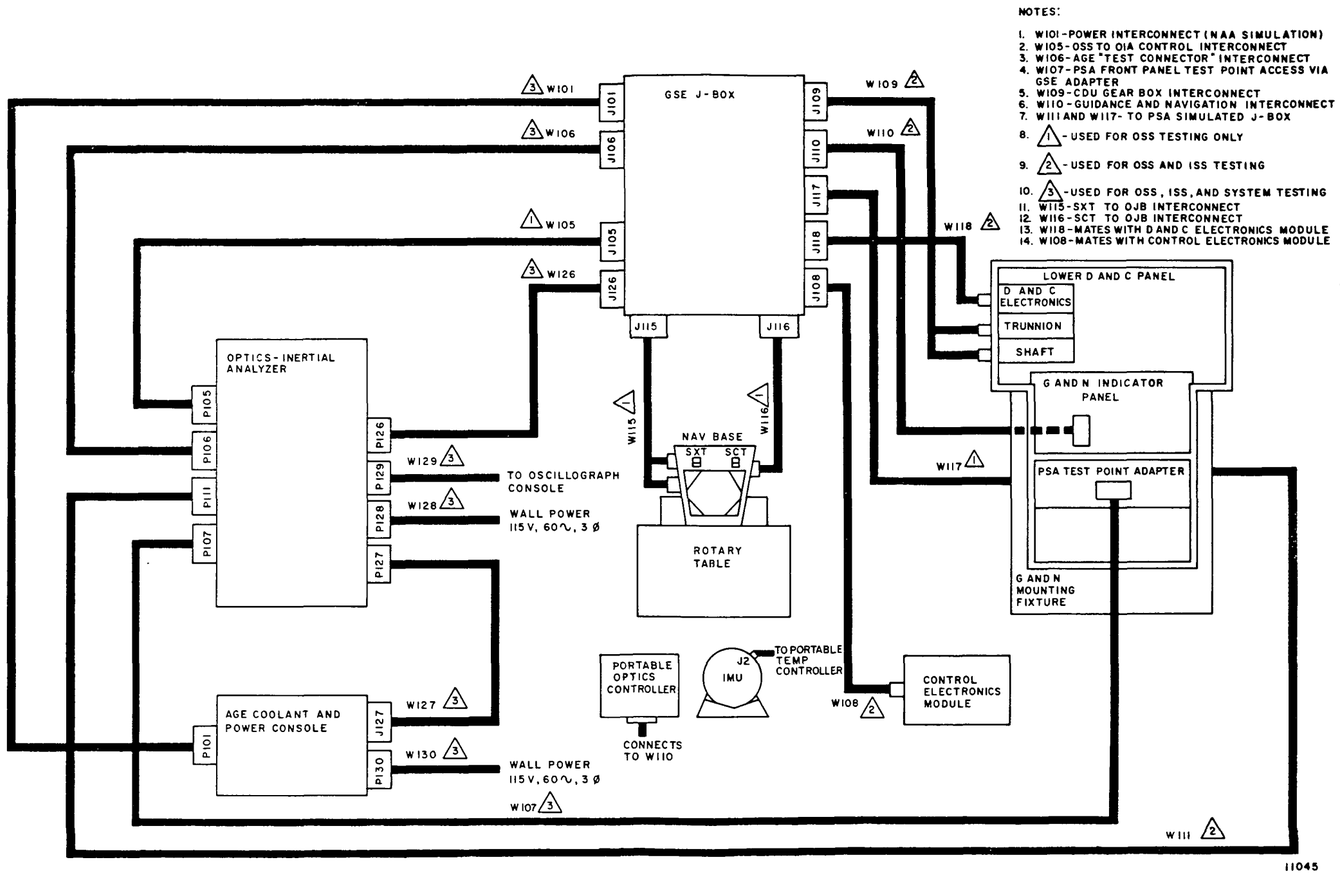
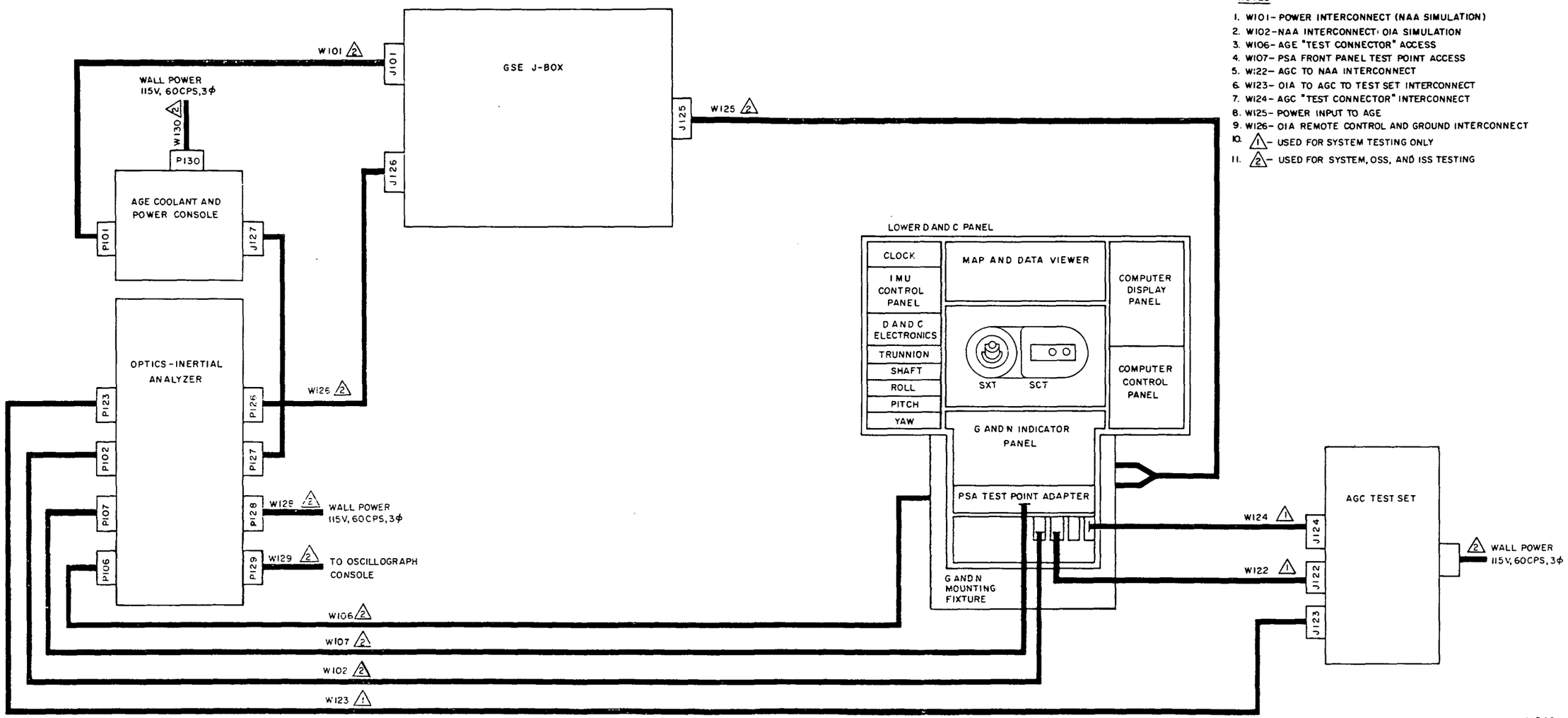


Figure 5-2. Optics-Inertial Test Set Tie-In During Optical Subsystem Testing



NOTES:

1. W101 - POWER INTERCONNECT (NAA SIMULATION)
2. W102 - NAA INTERCONNECT: OIA SIMULATION
3. W106 - AGE "TEST CONNECTOR" ACCESS
4. W107 - PSA FRONT PANEL TEST POINT ACCESS
5. W122 - AGC TO NAA INTERCONNECT
6. W123 - OIA TO AGC TO TEST SET INTERCONNECT
7. W124 - AGC "TEST CONNECTOR" INTERCONNECT
8. W125 - POWER INPUT TO AGE
9. W126 - OIA REMOTE CONTROL AND GROUND INTERCONNECT
10. (1) - USED FOR SYSTEM TESTING ONLY
11. (2) - USED FOR SYSTEM, OSS, AND ISS TESTING

Figure 5-3. Optics-Inertial Test Set Tie-In During G and N System Testing

Chapter 6

CHECKOUT AND ANALYSIS

6-1 CHECKOUT

Information required to check out and calibrate the optics-inertial test set in accordance with the current maintenance plan is contained in table 6-I. Unless otherwise specified, there is no specific order in which the JDC's listed must be performed. Readings shall be recorded, when required, on JDC data sheets (figure 6-1).

6-2 TROUBLE ANALYSIS

To perform trouble analysis of the optics-inertial test set, refer to the diagrams and lists given in tables 6-II and 6-III. For additional information, refer to chapters 1 and 4 of this manual.

TEST DATE: OPERATOR:	JDC _____ REV _____
JOB:	SHEET _____ OF _____
DESCRIPTION:	EQUIPMENT SERIAL NO.

JDC STEP NUMBER	PARAMETER	UNITS	REQUIRED VALUE	RECORDED VALUES			REJ	ACC
				1st	2nd*	3rd*		

SAMPLE

*To be used as required or desired

REMARKS:

11193

Figure 6-1. Data Sheet for Use with Optics-Inertial Test Set Checkout and Calibration JDC's

Table 6-I. Checkout and Calibration Information

Component	Checkout or Calibration Interval	Procedures To Be Performed	Remarks
Optics-inertial analyzer, 1900004			Calibrated on drawer basis only
Monitor panel, 1900055	----	JDC 19100	(To be supplied) Perform JDC's 19120 through 19130 before performing JDC 19100.
Wheel power fail and CDU motor excitation failure sensor, 1900370	90 days	JDC 19120	
X, Y, and Z PIPA error sensors, 1900372	90 days	JDC 19121	
IG, MG, and OG CDU error sensors, 1900373	90 days	JDC 19122	
IMU, accelerometer, and CDU failure indicator sensors, 1900374	90 days	JDC 19123	
IMU temperature failure indicator sensors, 1900376	----	----	No calibration required.
IG, MG, and OG servo error sensors, 1900376	90 days	JDC 19124	
AGC spare, AGC power fail error detect, and IMU delay failure indicator sensors, 1900378	----	----	No calibration required.

(cont)

Table 6-I. Checkout and Calibration Information (cont)

Component	Checkout or Calibration Interval	Procedures To Be Performed	Remarks
3200-cps voltage comparator, 1900487	90 days	JDC 19125	
Encoder excitation failure sensor, 1900419	90 days	JDC 19126	
±28-vdc pilot power supply, 1900492	90 days	JDC 19127	
Encoder zeroing and -28-vdc sensor, 1900613	----	----	No calibration required.
Verification assembly, 1900707	90 days	JDC 19129	
3200-cps frequency comparator, 1900447	90 days	JDC 19130	
Temperature monitor and control panel, 1900058	----	JDC 19220	(To be supplied.)
AGC simulator, 1014061	----	----	See computer simulator checkout, maintenance, and repair manual.
Power supply and load panel, 1900702	120 days	JDC 19200	Perform JDC's 19210 and 19211 before performing JDC 19200.
115-volt, 400-cps power supply, 1900726	120 days	JDC 19210	
2-volt, 3200-cps power supply, 1900081	120 days	JDC 19211	

(cont)

Table 6-I. Checkout and Calibration Information (cont)

Component	Checkout or Calibration Interval	Procedures To Be Performed	Remarks
Fan, 1900350-011, 1900350-021	----	----	No calibration required; maintenance only.
Monitor oscilloscope, 1900038	90 days	----	Two components per assembly. See commercial manual.
Gimbal position control panel, 1900054	90 days	----	Calibrated on module basis only.
IG, MG, and OG precision alignment servo amplifiers, 1900339, 1900337, 1900326	90 days	JDC 19165	
Phase sensitive error detector, 1900320	90 days	JDC 19168	
Gimbal dump protection assemblies, 1900269-011, 1900269-021, 1900269-031	90 days	JDC 19169	
Gimbal position display, 1900300	90 days	----	Calibrated by performing JDC's 19170 and 19171.
Gimbal position control, 1-speed resolver, 1015969	90 days	JDC 19170	
Gimbal position control 16-speed resolver, 1015968	90 days	JDC 19171	
Test control panel, 1900059	----	----	No calibration required.

(cont)

Table 6-I. Checkout and Calibration Information (cont)

Component	Checkout or Calibration Interval	Procedures To Be Performed	Remarks
Test selector panel, 1900082	----	----	No calibration required.
Phase shift panel, 1900163	----	----	No calibration required.
Digital recorder panel, 1900052	----	----	No calibration required; see commercial manual for repair.
Electronics power supply, 1900035	----	----	No calibration required.
Dual beam oscilloscope, 1900037	30 days	----	See commercial manual.
Primary signal selector panel, 1900057	----	----	No calibration required.
Coaxial distribution panel, 1900166	----	----	No calibration required.
Crossbar switch, 1900048	----	----	No calibration required.
Digital voltmeter, 1900042	90 days	----	See commercial manual.
Phase angle voltmeter, 1900036	30 days	----	See commercial manual.
Counter, 1900041	180 days	----	See commercial manual.
Oscillograph signal selector panel, 1900056	90 days	JDC 19180	Perform JDC's 19191 through 19194 before performing JDC 19180.
Buffer amplifier (phase generator), 1900132	90 days	JDC 19191	

(cont)

Table 6-I. Checkout and Calibration Information (cont)

Component	Checkout or Calibration Interval	Procedures To Be Performed	Remarks
Buffer amplifier (800-cps, $\pi/2$-phase), 1900138	90 days	JDC 19192	
Buffer amplifier (800-cps, 0-phase), 1900181	90 days	JDC 19193	
Buffer amplifier (3200-cps), 1900140	90 days	JDC 19194	
Signal generator, 1900043	90 days	----	See commercial manual.
Relay and lamp power supply, 1900049	----	----	No calibration required.
AC power protection panel, 1900075	----	----	No calibration required.
Oscillograph console, 1900000	----	----	No calibration required.
AGE coolant and power console, 1900145	----	----	Calibrated on drawer basis only.
Emergency shutdown panel, 1900868	----	----	No calibration required.
Guidance system power supply, 1900033	----	----	No calibration required.
Galvanometer, 1900034	90 days	----	See commercial manual.

(cont)

Table 6-I. Checkout and Calibration Information (cont)

Component	Checkout or Calibration Interval	Procedures To Be Performed	Remarks
Current source monitor panel, 1900053	----	----	(To be supplied.)
Coolant supply panel, 1900098	----	----	See coolant supply checkout, maintenance, and repair manual.
GSE junction box, 1900433	----	----	No calibration required.

Table 6-II. Troubleshooting Reference Information

Component	Schematic Diagram	Wire List	Wire Harness	Wiring Diagram
Monitor panel		1900856	1900196 1900852	
Wheel power fail and CDU motor excitation failure sensor	1900434	1900435		
X, Y, and Z PIPA error sensor	1900440	1900439		
IG, MG, and OG CDU error sensor	1900685	1900684		
IMU, accelerometer, and CDU failure indicator sensor	1900446	1900445		
IG, MG, and OG servo error sensor	1900437	1900438		
AGC spare, AGC power fail error detect, and IMU delay failure indicator sensor	1900382		1900383	
3200-cps voltage comparator	1900619	1900620		
Encoder excitation failure sensor	1900454	1900453		
±28-vdc pilot power supply	1900697	1900698		
Encoder zeroing and -28-vdc sensor	1900612	1900611		
Verification assembly	1900700	1900701		
3200-cps frequency comparator	1900703	1900844 1900845 1900846 1900847		
IMU temperature failure indicator sensor	1900406		1900405	
Temperature monitor and control panel			1900148	
Power supply and load panel	1900738		1900849	
115-volt, 400-cps power supply	1900733	1900734	1900735 1900736	

(cont)

Table 6-II. Troubleshooting Reference Information (cont)

Component	Schematic Diagram	Wire List	Wire Harness	Wiring Diagram
2-volt, 3200-cps power supply	1900341		1900418	
Gimbal position control panel	1900455		1900185	
IG precision alignment servo amplifier	1900263	1900329 1900332 1900335 1900336		
MG precision alignment servo amplifier	1900362	1900329 1900332 1900335 1900336		
OG precision alignment servo amplifier	1900361	1900329 1900332 1900335 1900336		
Phase sensitive error detector	1900319	1900322		
Gimbal dump protection assembly	1900176	1900317 1900318		
Gimbal position display	1900286 1900395			
Test control panel	1900649	1900615 1900616	1900186 1900614	
Test selector panel	1900692		1900187	
Phase shift panel	1900431		1900197	1900432
Digital recorder panel	1900242	1900821	1900705	1900241
Primary signal selector panel	1900498	1900778	1900096 1900779	
Coaxial distribution panel	1900266	1900208	1900206	1900267
Oscillograph signal selector panel	1900648		1900097 1900394	

(cont)

Table 6-II. Troubleshooting Reference Information (cont)

Component	Schematic Diagram	Wire List	Wire Harness	Wiring Diagram
Buffer amplifier (phase generator)	1900129	1900134	1900135	
Buffer amplifier (800-cps, $\pi/2$-phase)	1900131	1900137	1900139	
Buffer amplifier (800-cps, 0-phase)	1900130	1900184	1900245	
Buffer amplifier (3200-cps)	1900128	1900142	1900246	
AC power protection panel	1900397		1900174 1900399	1900398
Current source monitor panel	1900083	1900276	1900275	

Table 6-III. List of Mechanization Diagrams

Name	Number
AGE-GSE grounding and isolation interface mechanization diagram	1900065
AGE-GSE signal selection mechanization diagram	1900066
GSE counter signal select mechanization diagram	1900077
GSE system and subsystem monitor display and controls mechanization diagram	1900089
GSE optics test mechanization diagram	1900100
GSE power control and distribution mechanization diagram	1900144
Test control mechanization diagram	1900258
Inertial subsystem test mechanization diagram	1900262

JOB: CALIBRATION OF WHEEL POWER FAIL AND CDU MOTOR EXCITATION FAILURE SENSOR	**JDC** 19120 (Sheet 1 of 2)
SUBSYSTEM: OPTICS-INERTIAL ANALYZER	**ASSEMBLY:** 60 A9A7 and 60 A9A10
DESCRIPTION: Procedure to check and adjust signal level at which error sensor produces malfunction indication.	**TYPE:** Calibrate **INTERVAL:** 90 Days
TOOLS AND MATERIAL: 1. Audio oscillator, HP-201C 2. DC power supply, Harrison Lab 808A 3. DC voltohmmeter, HP-412A 4. Differential voltmeter, Fluke 803	**REFERENCES:** ATP 1900370 Sch 1900434 Wire list 1900435
IMPORTANT: None	

A. PREPARATION: NA

B. PROCEDURE:

CAUTION: Equipment must be turned off whenever any power connections are being made.

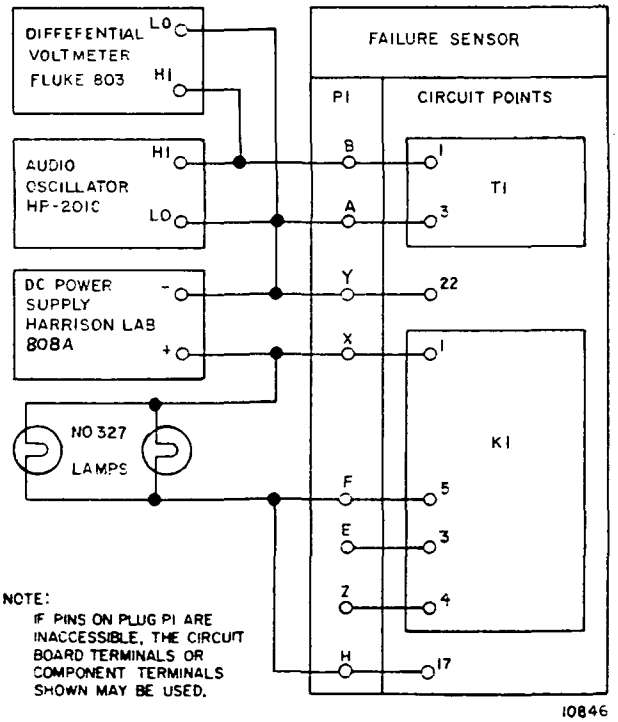
1. Establish test setup as shown.

NOTE: To obtain maximum accuracy from test equipment during the following procedures, 30 minutes warmup time must be allowed.

2. Set audio oscillator to 0 volt, 800 cps.

NOTE: Use dc voltohmmeter to make all dc voltage measurements in the following steps.

3. Set dc power supply output to 28 (± 1) volts.
4. Connect dc voltohmmeter to P1-E (+) and P1-Y (-).
5. Set audio oscillator output voltage past point at which relay K1 is deenergized.



Test Setup

(When K1 is deenergized, dc voltohmmeter indicates 0 volt.)

6. Decrease audio oscillator output voltage until relay K1 energizes. (When K1 is energized, dc voltohmmeter indicates 28 volts.)
7. Read and record the audio oscillator output voltage at which relay K1 energized.
8. Set audio oscillator output to 15.8 (± 0.2) volts.
9. Set potentiometer R1 approximately one-half turn counterclockwise past point at which relay K1 energizes.
10. Adjust potentiometer R1 clockwise until relay K1 deenergizes.
11. Set audio oscillator output to 16 (± 0.16) volts. Relay K1 shall be deenergized.
12. Decrease output of audio oscillator until relay K1 energizes.
13. Read and record the audio oscillator output voltage at which relay K1 energized. Voltage shall be greater than 14 volts.
14. Set audio oscillator output to 14 (± 0.14) volts.
15. Read and record dc voltage between P1-H (+) and P1-Y (-). Voltage shall be less than 1 volt.
16. Dismantle test setup.

C. CALCULATIONS: NA

D. RESULTS: NA

JOB: CALIBRATION OF X, Y, AND Z PIPA ERROR SENSOR	**JDC** 19121 (Sheet 1 of 2)
SUBSYSTEM: OPTICS-INERTIAL ANALYZER	**ASSEMBLY:** 60 A9A23, 60 A9A20, and 60 A9A17
DESCRIPTION: Procedure to check and adjust signal level at which error sensor produces malfunction indication.	**TYPE:** Calibrate **INTERVAL:** 90 Days
TOOLS AND MATERIAL: 1. Audio oscillator, HP-201C 2. DC power supply, Harrison Lab 808A 3. Decade resistance box, Clarostat 240C 4. DC voltohmmeter, HP-412A 5. Vacuum tube voltmeter, HP-400H	**REFERENCES:** ATP 1900372 Sch 1900440 Wire list 1900439
IMPORTANT: None	

A. PREPARATION: NA

B. PROCEDURE:

CAUTION: Equipment must be turned off whenever any power connections are being made.

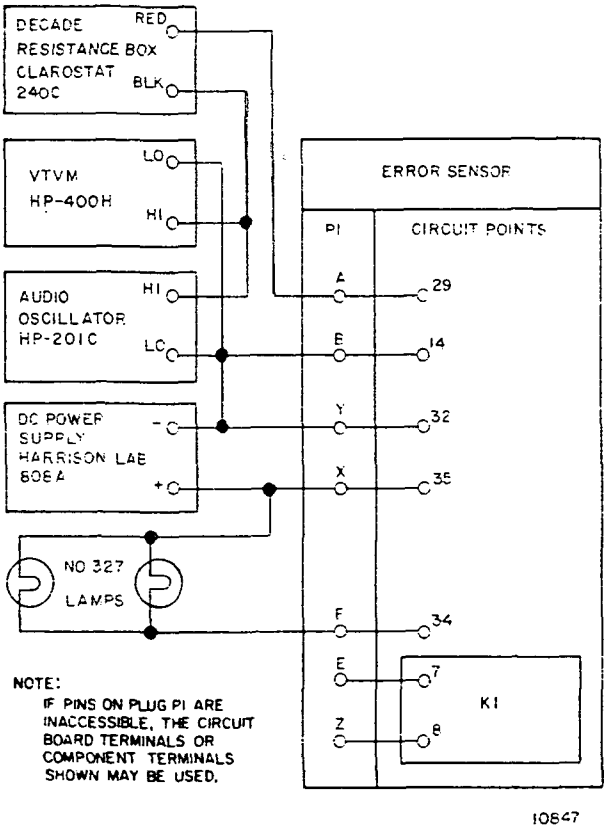
1. Establish test setup as shown:

NOTE: To obtain maximum accuracy from test equipment during the following procedures, 15 minutes warmup time must be allowed.

2. Set audio oscillator to 0 volts, 3200 cps.
3. Set decade resistance box to 1200 ohms.

NOTE: Use dc voltohmmeter to make all dc voltage measurements in the following steps.

4. Set dc power supply output to 28 (± 1) volts.
5. Connect dc voltohmmeter to P1-E (+) and P1-Y (-).
6. Check that relay K1 is deenergized. (When



Test Setup

K1 is deenergized, dc voltohmmeter indicates 0 volts.)

7. Increase audio oscillator output until relay K1 energizes. (When K1 is energized, dc voltohmmeter indicates 28 volts dc.)
8. Read and record audio oscillator output voltage at which relay K1 is energized.
9. Set audio oscillator output to 3.9 (± 0.05) volts.
10. Set potentiometer approximately one-half turn counterclockwise past point at which relay K1 deenergizes.
11. Adjust potentiometer R3 clockwise until relay K1 energizes.
12. Set audio oscillator output to 3.75 volts. Relay K1 shall be deenergized.
13. Increase audio oscillator output until relay K1 energizes.
14. Read and record audio oscillator output voltage at which relay K1 energized. Voltage shall be less than 4.05 volts.
15. Set audio oscillator output to 4.05 volts.
16. Read and record dc voltage between P1-F (+) and P1-Y (-). Voltage shall be less than one volt.
17. Dismantle test setup.

C. CALCULATIONS: NA

D. RESULTS: NA

JOB: CALIBRATION OF IG, MG, AND OG CDU ERROR SENSOR	**JDC** 19122 (Sheet 1 of 2)
SUBSYSTEM: OPTICS-INERTIAL ANALYZER	**ASSEMBLY:** 60 A9A27, 60 A9A24, and 60 A9A21
DESCRIPTION: Procedure to check and adjust signal level at which sensor circuit produces malfunction indication.	**TYPE:** Calibrate **INTERVAL:** 90 Days
TOOLS AND MATERIAL: 1. Function generator, HP-202A 2. DC power supply, Harrison Lab 808A 3. Oscilloscope, Tektronix 545A 4. Decade resistance box, Clarostat 240C 5. DC voltohmmeter, HP-412A	**REFERENCES:** ATP 1900373 Sch 1900685 Wire list 1900684
IMPORTANT: None	

A. PREPARATION: NA

B. PROCEDURE:

CAUTION: Equipment must be turned off whenever any power connections are being made.

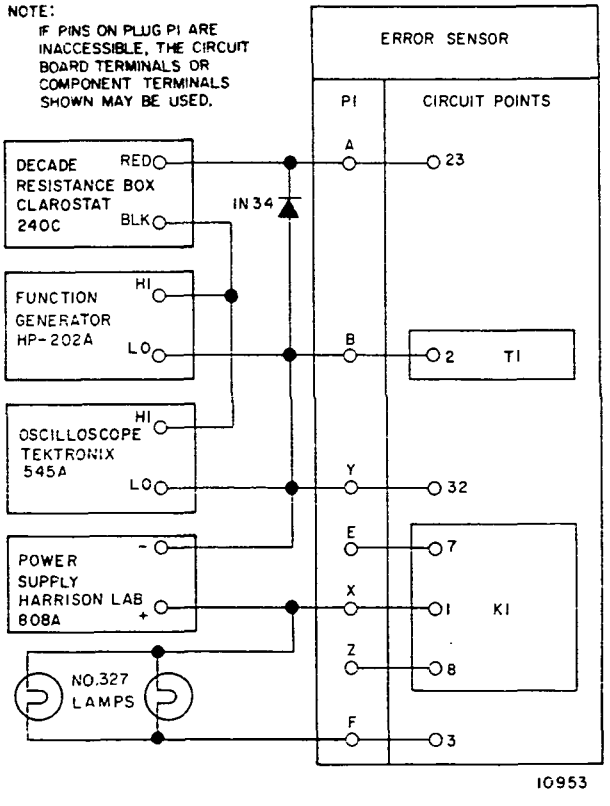
1. Establish test setup as shown.

NOTE: To obtain maximum accuracy from test equipment during the following procedures, 15 minutes warmup time must be allowed.

2. Set function generator to produce square waves.
3. Set function generator to 0 volt, 800 cps.
4. Set decade resistance box to 5100 ohms.

NOTE: Use dc voltohmmeter to make all dc voltage measurements in the following steps; the output of the function generator is measured by the oscilloscope.

5. Set dc power supply output to 28 (± 1) volts.



Test Setup

6. Connect dc voltohmmeter to P1-E (+) and P1-Y (-).
7. Set function generator output to 0 volt. Relay K1 shall be deenergized. (When K1 is deenergized, dc voltohmmeter indicates 0 volt.)
8. Increase function generator output until relay K1 energizes. (When K1 is energized, dc voltohmmeter indicates 28 volts.)
9. Read and record the function generator peak-to-peak output voltage at which relay K1 energized.
10. Set function generator output to 4.5 (± 0.1) volts peak to peak.
11. Set potentiometer R3 approximately one-half turn counterclockwise past point at which relay K1 deenergizes.
12. Adjust potentiometer R3 clockwise until relay K1 energizes.
13. Set function generator output to 4.1 volts peak to peak. Relay K1 shall be deenergized.
14. Increase function generator output until relay K1 energizes.
15. Read and record function generator output voltage at which relay K1 energized. Voltage shall be less than 4.9 volts peak to peak.
16. Set function generator output to 4.9 volts peak to peak.
17. Read and record dc voltage between P1-F (+) and P1-Y (-). Voltage shall be less than 1 volt.
18. Dismantle test setup.

C. CALCULATIONS: NA

D. RESULTS: NA

JOB: CALIBRATION OF IMU, ACCELEROMETER, AND CDU FAILURE INDICATOR SENSOR	**JDC** 19123 (Sheet 1 of 2)
SUBSYSTEM: OPTICS-INERTIAL ANALYZER	**ASSEMBLY:** 60 A9A19, 60 A9A13, and 60 A9A16
DESCRIPTION: Procedure to check and adjust signal level at which error sensor produces malfunction indication.	**TYPE:** Calibrate **INTERVAL:** 90 Days
TOOLS AND MATERIAL: 1. Pulse generator, E-H Lab 130 2. DC power supply, Harrison Lab 808A 3. Oscilloscope, Tektronix 545A 4. DC voltohmmeter, HP-412A	**REFERENCES:** ATP 1900374 Sch 1900446 Wire list 1900445
IMPORTANT: None	

A. PREPARATION: NA

B. PROCEDURE:

CAUTION: Equipment must be turned off whenever any power connections are being made.

1. Establish test setup as shown.

NOTE: To obtain maximum accuracy from test equipment during the following procedures, 15 minutes warmup time must be allowed.

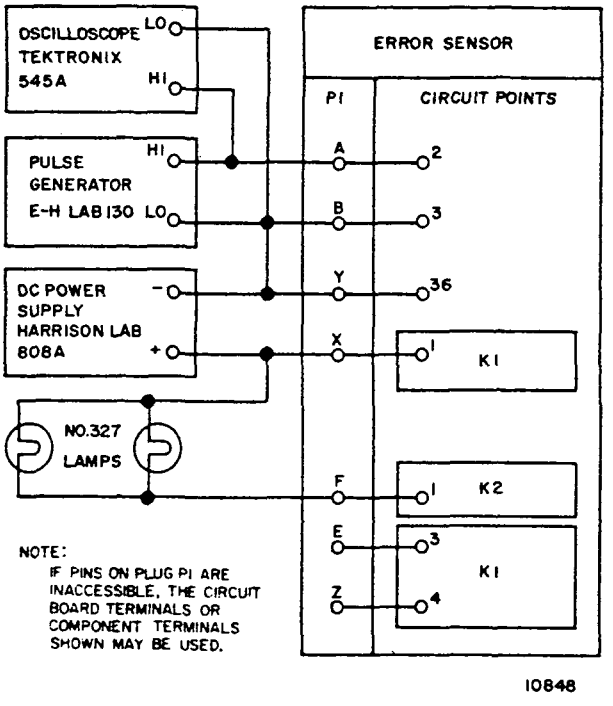
2. Set pulse generator pulse width to 2 (± 0.5) microseconds.

3. Set pulse generator frequency to 102,400 (±5120) pulses per second.

NOTE: Use dc voltohmmeter to make all dc voltage measurements in the following steps.

4. Set dc power supply output to 28 (± 3) volts.

5. Connect dc voltohmmeter to P1-E (+) and P1-Y (-).



Test Setup

6. Set pulse generator output to 0 volt. Relay K1 shall be deenergized. (When K1 is deenergized, dc voltohmmeter indicates 0 volt.)
7. Increase pulse generator output until relay K1 energizes. (When K1 is energized, dc voltohmmeter indicates 28 volts.)
8. Read and record pulse generator output voltage at which relay K1 energized.
9. Set pulse generator output to 3.15 (± 0.15) volts.
10. Set potentiometer R2 approximately one-half turn counterclockwise past point at which relay K1 deenergizes.
11. Adjust potentiometer R2 clockwise until relay K1 energizes.
12. Set pulse generator output to 2.75 (± 0.25) volts. Relay K1 shall be deenergized.
13. Increase pulse generator output until relay K1 energizes.
14. Read and record pulse generator output voltage at which relay K1 energized. Voltage shall be less than 5 volts.
15. Set pulse generator output to 5 (± 0.25) volts.
16. Read and record dc voltage between P1-F (+) and P1-Y (-). Voltage shall be less than 1 volt.
17. Dismantle test setup.

C. CALCULATIONS: NA

D. RESULTS: NA

JOB: CALIBRATION OF IG, MG, AND OG SERVO ERROR SENSOR	**JDC** 19124 (Sheet 1 of 2)
SUBSYSTEM: OPTICS-INERTIAL ANALYZER	**ASSEMBLY:** 60 A9A14, 60 A9A11, and 60 A9A8
DESCRIPTION: Procedure to check and adjust signal level at which error sensor produces malfunction indication.	**TYPE:** Calibrate **INTERVAL:** 90 Days
TOOLS AND MATERIAL: 1. Audio oscillator, HP-210C 2. DC power supply, Harrison Lab 808A 3. DC voltohmmeter, HP-412A 4. Differential voltmeter, Fluke 803 5. Decade resistance box, Clarostat 240C	**REFERENCES:** ATP 1900376 Sch 1900437 Wire list 1900438
IMPORTANT: None	

A. PREPARATION: NA

B. PROCEDURE:

CAUTION: Equipment must be turned off whenever power connections are being made.

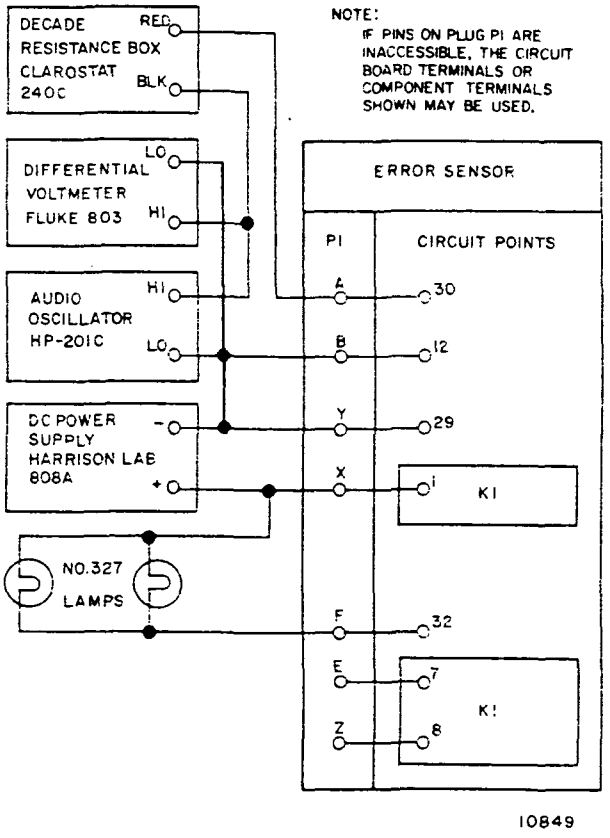
1. Establish test setup as shown.

   NOTE: To obtain maximum accuracy from test equipment during the following procedures, 30 minutes warmup time must be allowed.

2. Set audio oscillator to 0 volt, 3200 cps.
3. Set decade resistance box to 5100 ohms.

   NOTE: Use dc voltohmmeter to make all dc voltage measurements in the following steps.

4. Set dc power supply output to 28 (± 1) volts.
5. Connect dc voltohmmeter to P1-E (+) and P1-Y (-).



Test Setup

6. Check that relay K1 is deenergized. (When K1 is deenergized, dc voltohmmeter indicates 0 volt.)
7. Increase audio oscillator output until relay K1 energizes. (When K1 is energized, dc voltohmmeter indicates 28 volts.)
8. Read and record audio oscillator output voltage at which relay K1 energized.
9. Set audio oscillator output to 5 (± 0.08) volts.
10. Set potentiometer R3 approximately one-half turn counterclockwise past point at which relay K1 deenergizes.
11. Adjust potentiometer R3 clockwise until relay K1 energizes.
12. Set audio oscillator output to 4.75 volts. Relay K1 shall be deenergized.
13. Increase audio oscillator output until relay K1 energizes.
14. Read and record audio oscillator output voltage at which relay K1 energized. Voltage shall be less than 5.25 volts.
15. Set audio oscillator output to 5.25 volts.
16. Read and record dc voltage between P1-F (+) and P1-Y (-). Voltage shall be less than one volt.
17. Dismantle test setup.

C. CALCULATIONS: NA

D. RESULTS: NA

JOB: CALIBRATION OF 3200-CPS VOLTAGE COMPARATOR	**JDC** 19125 (Sheet 1 of 2)
SUBSYSTEM: OPTICS-INERTIAL ANALYZER	**ASSEMBLY:** 60 A9A6
DESCRIPTION: Procedure to check and adjust signal level at which 3200-cps comparator operates.	**TYPE:** Calibrate **INTERVAL:** 90 Days
TOOLS AND MATERIAL: 1. Audio oscillator, HP-201C 2. DC power supply, Harrison Lab 808A 3. Vacuum tube voltmeter, HP-400H 4. DC voltohmmeter, HP-412A	**REFERENCES:** ATP 1900487 Sch 1900619 Wire list 1900620
IMPORTANT: None	

A. PREPARATION: NA

B. PROCEDURE:

CAUTION: Equipment must be turned off whenever any power connections are being made.

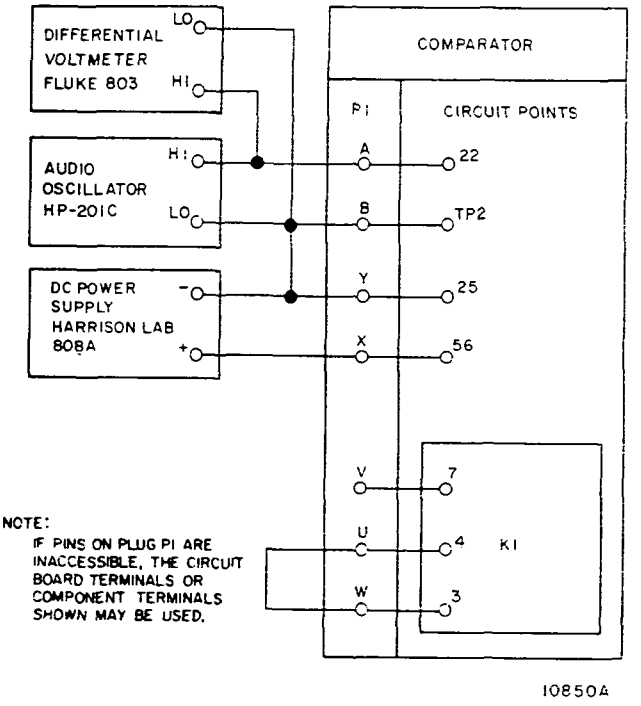
1. Establish test setup as shown.

NOTE: To obtain maximum accuracy from test equipment during the following procedures, 15 minutes warmup time must be allowed.

2. Set audio oscillator to 0 volt, 3200 (+ 320, -32) cps.

NOTE: Use dc voltohmmeter to make all dc voltage measurements in the following steps.

3. Set dc power supply output to 28 (± 1) volts.
4. Connect dc voltohmmeter to P1-V (+) and P1-Y (-).



Test Setup

5. Check that relay K1 is deenergized. (When relay K1 is deenergized, dc voltohmmeter shall indicate 0 volt.)
6. Increase audio oscillator output until relay K1 energizes. (When relay K1 is energized, dc voltohmmeter shall indicate 28 volts dc.)
7. Read and record audio oscillator output voltage at which relay K1 energized.
8. Increase audio oscillator output until relay K1 deenergizes.
9. Read and record audio oscillator output voltage at which relay K1 deenergized.
10. Set audio oscillator output to 1.8 volts (± 5.0) millivolts).
11. Set potentiometer R3 fully clockwise.
12. Set potentiometer R2 approximately one-half turn counterclockwise past point at which relay K1 deenergizes.
13. Adjust potentiometer R2 until relay K1 energizes.
14. Set audio oscillator output to 2.2 volts (± 5.0 millivolts). Relay K1 shall be deenergized.
15. Adjust potentiometer R3 until relay K1 energizes.
16. Set audio oscillator output to 0 volt. Relay K1 shall be deenergized.
17. Increase audio oscillator output until relay K1 energizes.
18. Read and record audio oscillator output voltage at which relay K1 energized. Voltage shall be 1.8 (± 0.03) volts.
19. Increase audio oscillator output until relay K1 deenergizes.
20. Read and record audio oscillator voltage at which relay K1 deenergized. Voltage shall be 2.2 (± 0.03) volts.
21. Set audio oscillator output to 2 volts.
22. Read and record dc voltage between terminal 5 of relay K1 (+) and P1-Y (-). Voltage shall be less than 1.5 volts.
23. Dismantle test setup.

C. CALCULATIONS: NA

D. RESULTS: NA

JOB: CALIBRATION OF ENCODER EXCITATION FAILURE SENSOR	**JDC** 19126 (Sheet 1 of 2)
SUBSYSTEM: OPTICS-INERTIAL ANALYZER	**ASSEMBLY:** 60 A9A22
DESCRIPTION: Procedure to check and adjust signal level at which sensor circuit produces malfunction indication.	**TYPE:** Calibrate **INTERVAL:** 90 Days
TOOLS AND MATERIAL: 1. Audio oscillator; HP-200CD 2. Power supply; Harrison Lab 808A 3. Differential voltmeter; Fluke 803 4. DC voltohmmeter; HP-412A	**REFERENCES:** ATP 1900419 Sch 1900454 Wire list 1900453
IMPORTANT: None	

A. PREPARATION: NA

B. PROCEDURE:

CAUTION: Equipment must be turned off whenever any power connections are being made.

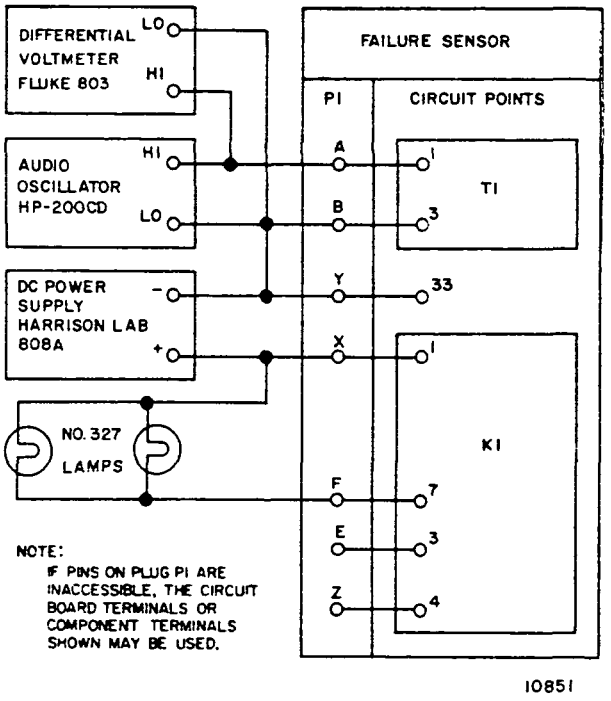
1. Establish test setup as shown.

NOTE: To obtain maximum accuracy from test equipment during the following procedures, 30 minutes warmup time must be allowed.

2. Set audio oscillator to 0 volts, 25 (±5) kc.

NOTE: Use dc voltohmmeter to make all dc voltage measurements in the following steps.

3. Set dc power supply to 28 (±1) volts.
4. Connect dc voltohmmeter to P1-E (+) and P1-Y (-).
5. Set audio oscillator output voltage past point at which relay K1 is deenergized. (When K1 is deenergized, dc voltohmmeter indicates 0 volts.)
6. Decrease audio oscillator output until



Test Setup

relay K1 energizes. (When K1 is energized, dc voltohmmeter indicates 28 volts.)

7. Read and record audio oscillator output voltage at which relay K1 energized.

8. Set audio oscillator output to 1.2 (±0.012) volts.

9. Set potentiometer R1 approximately one-half turn counterclockwise past point at which relay K1 deenergizes.

10. Adjust potentiometer R1 clockwise until relay K1 energizes.

11. Set audio oscillator output to 1.32 (±0.013) volts. Relay K1 shall be deenergized.

12. Decrease audio oscillator output until K1 energizes.

13. Read and record audio oscillator output voltage at which relay K1 energized. Voltage shall be greater than 1.18 volts.

14. Set audio oscillator output to 1.18 (±0.012) volts.

15. Read and record dc voltage between P1-F (+) and P1-Y (-). Voltage shall be less than 1 volt.

16. Dismantle test setup.

C. CALCULATIONS: NA

D. RESULTS: NA

JOB: CALIBRATION OF ±28-VOLT DC POWER SUPPLY	**JDC** 19127 (Sheet 1 of 2)
SUBSYSTEM: OPTICS-INERTIAL ANALYZER	**ASSEMBLY:** 60 A9A1
DESCRIPTION: Procedure to check and adjust output level of ±28-volt dc power supply.	**TYPE:** Calibrate **INTERVAL:** 90 Days
TOOLS AND MATERIAL: See Below.	**REFERENCES:** ATP 1900492 Sch 1900697 Wire List 1900698
IMPORTANT: None	

1. Autotransformer, General Radio W5MT3A;
2. Transformer, P/N 1016104;
3. Decade resistance box, Clarostat 240C (2 required);
4. Differential voltmeter, Fluke 803

A. PREPARATION: NA

B. PROCEDURE:

CAUTION: Equipment must be turned off whenever any power connections are being made.

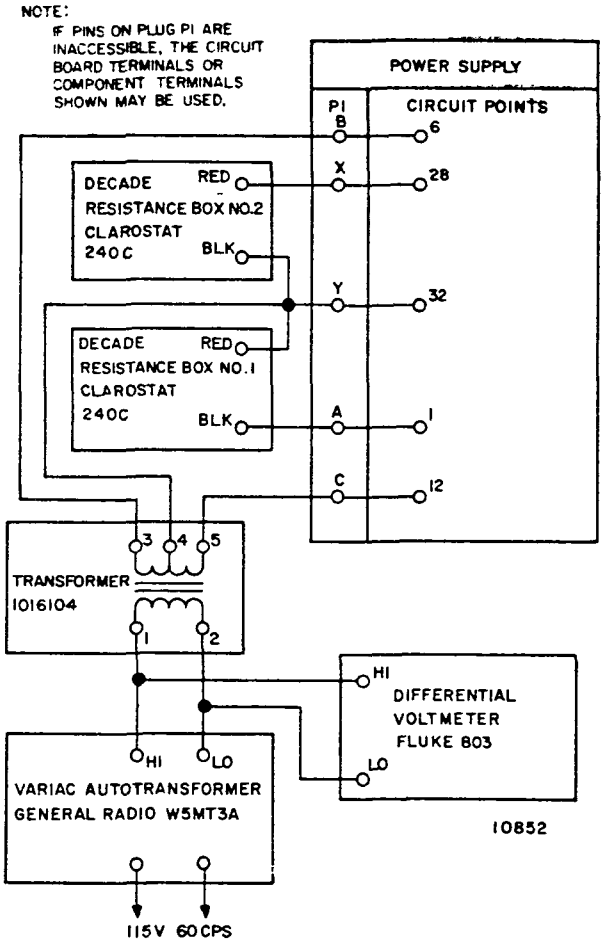
1. Establish test setup as shown.

NOTE: To obtain maximum accuracy from test equipment during the following procedures, 30 minutes warmup time must be allowed.

NOTE: Use differential voltmeter to measure all voltages, including ripple, in the following procedures.

2. Check power supply outputs as indicated in the table. Record all output readings.

3. Set decade resistance box no. 2 to 56 ohms.



Test Setup

4. Set autotransformer output to 115 (± 1.15) volts.
5. Adjust potentiometer R8 until differential voltmeter indicates 28 (+ 0.28) volts dc at P1-X (+) and P1-Y (-).
6. Repeat step 2.
7. Dismantle test setup.

C. CALCULATION: NA

D. RESULTS: NA

Autotransformer Setting (± 1%)	Decade Resistance Box No. 1 Setting	Decade Resistance Box No. 2 Setting	Outputs (±5%)		Ripple P1-X(+) to P1-Y(-)
			P1-X(+) to P1-Y(-)	P1-A(+) to P1-Y(-)	
115 volts	500 ohms	56 ohms	28 volts dc	-30 volts dc	100 millivolts maximum
105 volts					
125 volts					
115 volts		35 ohms			150 millivolts maximum
115 volts		Open circuit			
115 volts		CAUTION: For this check, insert a momentary on-off switch between P1-X and decade resistance box no. 2. 1 ohm	150 millivolts dc maximum		NA

JOB: TEST OF VERIFICATION ASSEMBLY	**JDC** 19129 (Sheet 1 of 2)
SUBSYSTEM: OPTICS-INERTIAL ANALYZER	**ASSEMBLY:** 60 A9A5
DESCRIPTION: Procedure to check output level and frequency of verification assembly.	**TYPE:** Test **INTERVAL:** 90 Days
TOOLS AND MATERIAL: 1. Counter, CMC 727B 2. DC power supply, Harrison Lab 808A 3. Vacuum tube voltmeter, HP-400H 4. DC voltohmmeter, HP-412A	**REFERENCES:** ATP 1900707 Sch 1900700 Wire list 1900701
IMPORTANT: None	

A. PREPARATION: NA

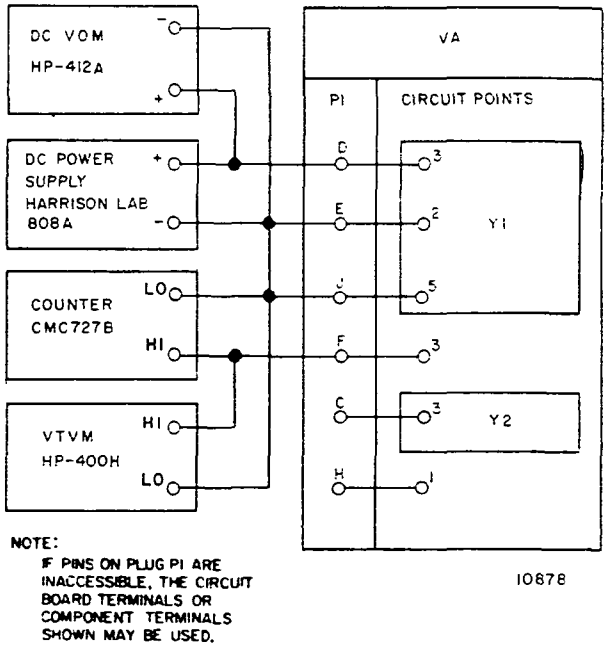
B. PROCEDURE:

CAUTION: Equipment must be turned off whenever any power connections are being made.

1. Establish test setup as shown.

NOTE: To obtain maximum accuracy from test equipment during the following procedures, 15 minutes warmup time must be allowed.

2. Set dc power supply to 28 (±3) volts.
3. Set potentiometer R4 fully clockwise.
4. Read and record vacuum tube voltmeter indication. Voltmeter shall indicate 4 volts or greater.
5. Read and record counter indication. Counter shall indicate 3600 (±3.6) cps.
6. Set potentiometer R4 fully counterclockwise. Voltmeter shall indicate 0.5 volt or less.



Test Setup

7. Adjust potentiometer R4 clockwise to obtain voltmeter indication of approximately 2 volts.
8. Disconnect dc power supply positive lead from P1-D and connect to P1-C.
9. Disconnect vacuum tube voltmeter hi lead from P1-F and connect to P1-H.
10. Disconnect counter hi lead from P1-F and connect to P1-H.
11. Set potentiometer R5 fully clockwise.
12. Read and record vacuum tube voltmeter indication. Voltmeter shall indicate 4 volts or greater.
13. Read and record counter indication. Counter shall indicate 3155 (±3.2) cps.
14. Set potentiometer R5 fully counterclockwise. Voltmeter shall indicate 0.5 volt or less.
15. Adjust potentiometer R5 clockwise to obtain voltmeter indication of approximately 2 volts.
16. Dismantle test setup.

C. CALCULATIONS: NA

D. RESULTS: NA

JOB: CALIBRATION OF 3200-CPS FREQUENCY COMPARATOR	**JDC** 19130 (Sheet 1 of 3)
SUBSYSTEM: OPTICS-INERTIAL ANALYZER	**ASSEMBLY:** 60 A9A3
DESCRIPTION: Procedure to check and adjust comparator operation.	**TYPE:** Calibrate **INTERVAL:** 90 days
TOOLS AND MATERIAL: 1. Audio oscillator, HP-201C 2. DC power supply, Harrison Lab 808A (2 required) 3. DC voltohmmeter, HP-412A 4. Counter, CMC 727B 5. Differential voltmeter, Fluke 803	**REFERENCES:** Sch 1900703 ATP 1900447 Wire lists 1900844, 1900845, 1900846, and 1900847
IMPORTANT: None	

A. PREPARATION: NA

B. PROCEDURE:

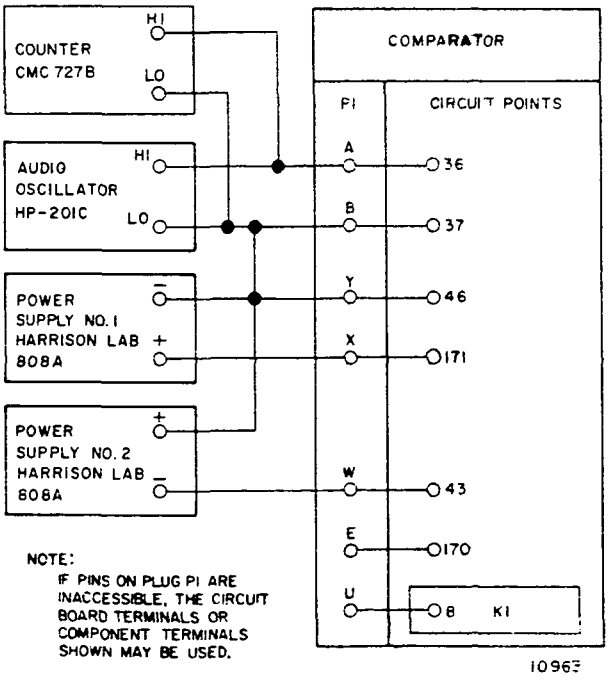
CAUTION: Equipment must be turned off whenever any power connections are being made.

1. Establish test setup as shown.

NOTE: To obtain maximum accuracy from the test equipment during the following procedures, 30 minutes warmup time must be allowed.

NOTE: Unless otherwise specified, use differential voltmeter to make all voltage measurements in the following procedures. The counter is used to check audio oscillator frequency.

2. Set power supply no. 1 to 28 (±1) volts dc.
3. Set power supply no. 2 to 30 (±1) volts dc.
4. Set audio oscillator output to 2 (±0.2) volts, 2500 cps.



Test Setup

5. Connect differential voltmeter to TP-1 (Hi) and TP-4 (Lo).

6. Increase audio oscillator frequency until voltage peak is indicated on differential voltmeter at approximately 3000 cps.

7. Record frequency at which voltage peak occurred.

8. Record voltage indicated on differential voltmeter.

9. Increase audio oscillator frequency until second voltage peak is indicated on differential voltmeter at approximately 3600 cps.

10. Record frequency at which voltage peak occurs.

11. Record voltage indicated on differential voltmeter.

12. The frequencies recorded in steps 7 and 10 shall be 3000 (±75) cps and 3625 (±75) cps, respectively, while the voltages recorded in steps 8 and 11 shall be within 40 millivolts of each other and between 1.5 and 2.0 volts ac.

13. If the requirements of step 12 are not met, adjust inductor L2 as necessary. After final adjustment of inductor L2, reverse adjusting screw of inductor L2 approximately 7 degrees.

14. Set audio oscillator output to 2500 (±50) cps. Indication on differential voltmeter shall be less than 0.6 volt.

15. Set audio oscillator output to 4200 (±50) cps. Indication on differential voltmeter shall be less than 1 volt.

16. Disconnect differential voltmeter and audio oscillator.

17. Measure and record ac voltage between P1-E (Hi) and P1-Y (Lo).

18. Voltage recorded in step 17 shall be 1.65 (+0.00, -0.05) volts rms. If necessary, adjust potentiometer R9 to obtain required voltage.

19. Measure and record dc voltage between TP-3(-) and TP-4(+).

20. Voltage recorded in step 19 shall be 16.5 (±0.5) volts dc. If necessary, adjust potentiometer R14 to obtain required voltage.

21. Reconnect audio oscillator as shown in test setup.

22. Set audio oscillator output to 2 volts, 3000 cps.

23. Connect dc voltohmmeter between P1-U(+) and P1-Y(-). Voltohmmeter indication shall be zero volts, indicating that relay K1 is deenergized.

24. Increase audio oscillator frequency until relay K1 energizes (28-volt indication on voltohmmeter) at approximately 3168 cps.

25. Record frequency at which relay K1 energized.

26. Increase audio oscillator frequency until relay K1 deenergizes (0-volt indication on voltohmmeter) at approximately 3520 cps.

27. Record frequency at which relay K1 deenergized.

28. Frequencies recorded in steps 25 and 27 shall be 3168 (±4) cps and 3520 (±10) cps, respectively. If both frequencies are in tolerance, proceed to step 33. If either frequency is out of tolerance, proceed to step 29.

29. Set audio oscillator frequency to 3168 (±1) cps.

30. Adjust potentiometer R38 to point at which rocking the adjustment causes relay K1 to energize and deenergize.

31. Set potentiometer R38 to point at which relay deenergizes.

32. Set audio oscillator to 3000 cps and repeat steps 24 through 28.

33. Set audio oscillator to 2 volts, 3200 (±5) cps.

34. Disconnect counter hi terminal from test setup.

35. Disconnect audio oscillator hi terminal from P1-A.

36. Connect counter and audio oscillator as shown in time delay test setup.

NOTE: Time delay in step 37 is defined as the interval between removal of audio oscillator signal from P1-A and deenergizing of relay K1.

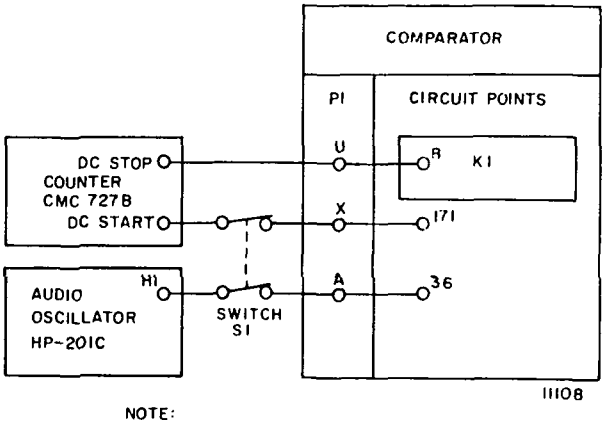
37. Using switch S1, simultaneously remove the input from P1-X and start counter operation. Deenergizing of relay K1 will stop counter operation.

38. Record comparator time delay as displayed on counter. Time delay shall be greater than 0.05 second.

39. Reconnect audio oscillator as shown in test setup.

40. Set audio oscillator output to 2.0 (±0.2) volts, 3200 (±5) cps.

41. Connect jumper between TP-2 and TP-4. Relay shall deenergize as jumper is connected.



NOTE:
IF PINS ON PLUG PI ARE INACCESSIBLE THE CIRCUIT BOARD TERMINALS OR COMPONENT TERMINALS SHOWN MAY BE USED

Time Delay Test Setup

42. Remove jumper between TP-2 and TP-4.

43. Connect jumper between TP-1 and TP-4. Relay shall deenergize as jumper is connected.

44. Dismantle test setup.

C. CALCULATIONS: NA

D. RESULTS: NA

JOB: CALIBRATION OF IG, MG, AND OG PRECISION SERVO AMPLIFIERS	**JDC** 19165 (Sheet 1 of 4)
SUBSYSTEM: OPTICS-INERTIAL ANALYZER	**ASSEMBLY:** 60 A11AR1, 60 A11AR2, and 60 A11AR3
DESCRIPTION: Procedure to check gain, phase angle, and phase response of precision servo amplifiers	**TYPE:** Calibrate **INTERVAL:** 90 days
TOOLS AND MATERIAL: See below.	**REFERENCES:** Sch 1900263, 1900362, 1900361 ATP 1900326, 1900337, 1900339 Wire lists 1900336, 1900329
IMPORTANT: None	

TOOLS AND MATERIALS:

1. DC power supply, Harrison Lab 808A (2 required)
2. Vacuum tube voltmeter, HP-400H
3. Spectrum analyzer, HP-302A
4. DC voltohmmeter, HP-412A
5. Phase angle voltmeter, Gertsch PAV-2
6. Oscilloscope, Tektronix 545A
7. Audio oscillator, HP-201C
8. Servo analyzer, Temco 10I
9. Decade resistance box, Clarostat 240C
10. Isolation transformer, 500 ohms
11. Potentiometer, 50,000 ohms

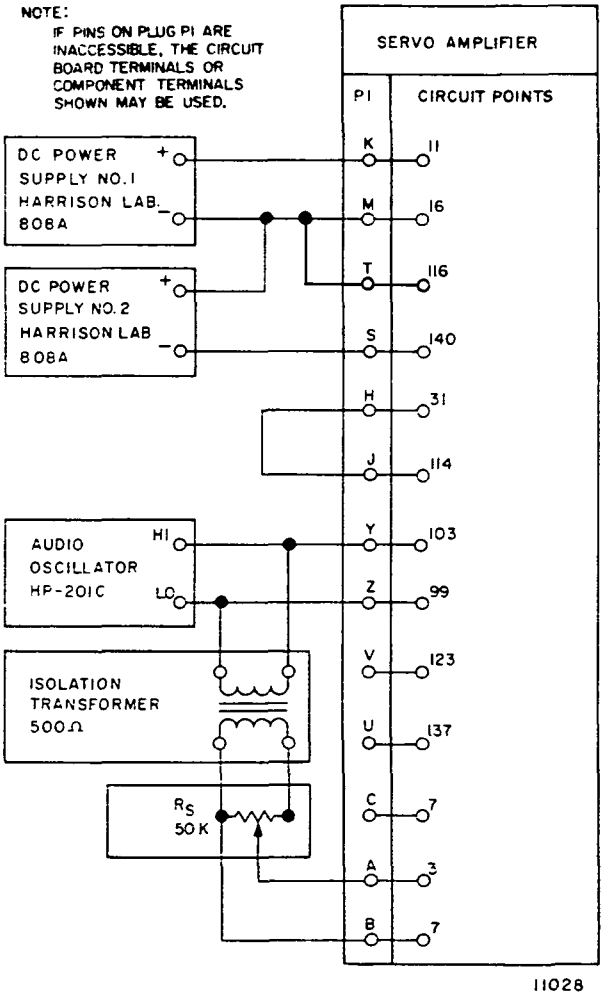
A. PREPARATION: NA

B. PROCEDURE:

CAUTION: Equipment must be turned off whenever any power connections are being made.

1. Establish test setup no. 1 as shown.

NOTE: To obtain maximum accuracy from test equipment during the following procedures, 30 minutes warmup time must be allowed.



Test Setup No. 1

NOTE: Make all ac voltage measurements in the following procedures with the vacuum tube voltmeter. Make all dc voltage measurements with the dc volt-ohmmeter.

2. Set dc power supplies no. 1 and no. 2 each to 30 (±1) volts dc.
3. Set audio oscillator output to 28 (±0.56) volts, 800 (±8) cps.
4. Adjust potentiometer R_s to obtain 0.2 volt ac between P1-A (Hi) and P1-B (Lo).
5. Set potentiometer R46 fully counterclockwise.
6. Measure and record ac voltage between P1-A (Hi) and P1-B (Lo).
7. Measure and record ac voltage between P1-H (Hi) and P1-B (Lo).
8. Divide reading in step 7 by reading in step 6. Record resultant ratio (gain). Gain shall be 5.5 (±0.7).
9. Use spectrum analyzer to measure distortion of output at P1-H (Hi) and P1-B (Lo). Record percentage of distortion. Distortion shall be less than five percent.
10. Set potentiometer R46 fully clockwise.
11. Measure and record ac voltage between P1-A (Hi) and P1-B (Lo).
12. Measure and record ac voltage between P1-H (Hi) and P1-B (Lo).
13. Divide reading in step 12 by reading in step 11. Record resultant ratio (gain). Gain shall be 13 (±1).
14. Use spectrum analyzer to measure distortion of output at P1-H (Hi) and P1-B (Lo). Record percentage of distortion. Distortion shall be less than five percent.
15. Adjust potentiometer R_s to obtain 0.5 volt ac between P1-A (Hi) and P1-B (Lo).
16. Adjust potentiometer R46 until ratio of output voltage [P1-H (Hi) and P1-B (Lo)] to input voltage [P1-A (Hi) and P1-B (Lo)] is 8 (±0.3).
17. Use spectrum analyzer to measure distortion of output at P1-H (Hi) and P1-B (Lo). Record percentage of distortion. Distortion shall be less than five percent.
18. Use phase angle voltmeter to measure phase angle between input [P1-A (Hi) and P1-B (Lo)] and output [P1-H (Hi) and P1-B (Lo)] . Record phase angle. Phase angle shall be 180 (±5) degrees.
19. Disconnect jumper from P1-H and P1-J.
20. Connect jumper between P1-B and P1-J.
21. Set decade resistance box to 50 (±2.5) ohms.
22. Connect decade resistance box between P1-U and P1-V.
23. Set potentiometer R29 fully clockwise.
24. Measure and record dc voltage between P1-U (+) and P1-V (-). Voltage shall be 28 (±3) volts dc.
25. Set potentiometer R29 12 (±9) revolutions counterclockwise from its fully clockwise position.
26. Measure and record dc voltage between P1-U (-) and P1-V (+). Voltage shall be 28 (±3) volts.
27. Adjust potentiometer R29 to obtain 0 (±5)

volts dc between P1-U (+) and P1-V (-).

28. Dismantle existing test setup.

29. Establish test setup no. 2 as shown.

30. Set dc power supplies no. 1 and no. 2 each to 30 (±1) volts dc.

31. Set audio oscillator output to 28 (±0.56) volts, 800 (±8) cps.

32. Set CARRIER INPUT switch on servo analyzer to 28 V.

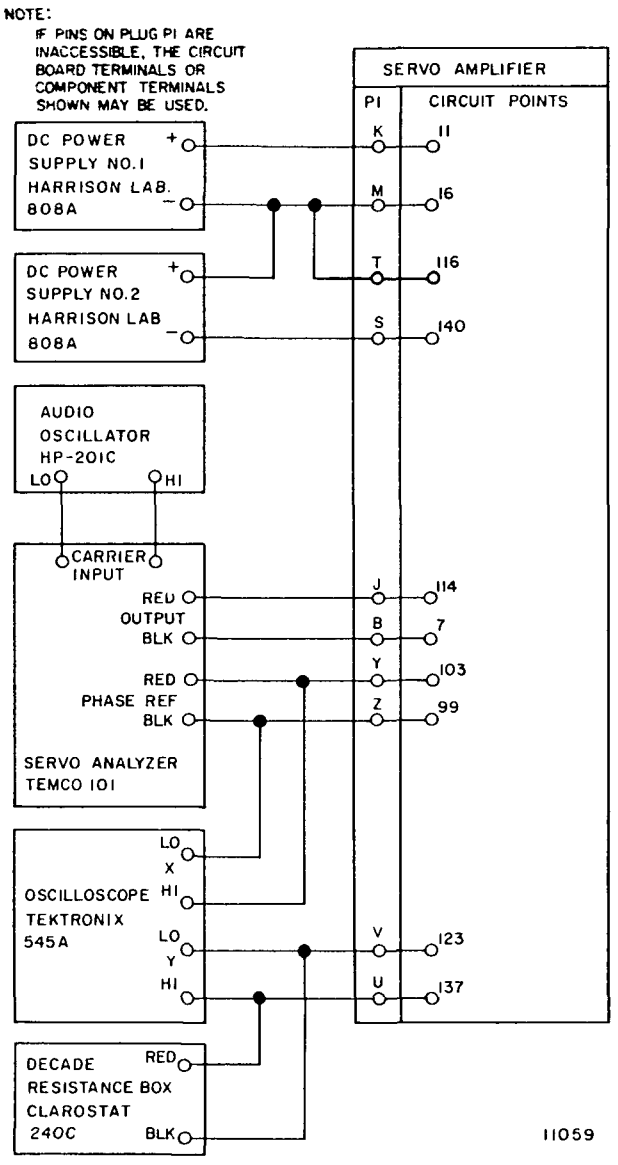
33. Set FUNCTION switch on servo analyzer to modulated sine position.

34. Adjust servo analyzer to obtain 0.2 volt ac at P1-J (Hi) and P1-B (Lo).

NOTE: Phase response in step 35 can be measured by adjusting PHASE LAG control on servo analyzer to obtain zero phase shift pattern (see figure) on oscilloscope.

35. Check phase response of amplifier at each modulating frequency given in table. The phase response of the amplifiers shall be as given in the table.

36. Adjust servo analyzer to obtain modulating frequency of 0 cps.



Test Setup No. 2

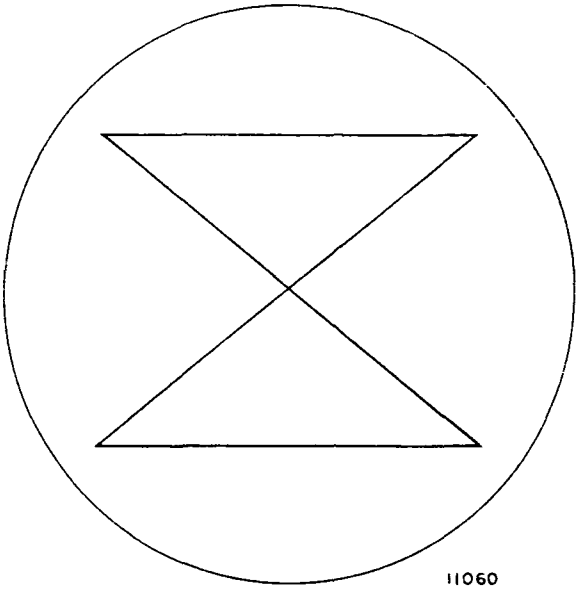
Table of Phase Response Checks

Inner Gimbal Amplifier Modulating Frequency (±5%)	Middle and Outer Gimbal Amplifiers Modulating Frequency (±5%)	Inner Gimbal Amplifier Phase Response (degrees)	Middle and Outer Gimbal Amplifier Phase Response (degrees)
100 cps	100 cps	Leading by 17 (±3)	Leading by 17 (±5)
70 cps	40 cps	Leading by 20 (±3)	Leading by 39 (±5)
55 cps	15 cps	Leading by 19 (±3)	Leading by 22 (±5)
4 cps	4 cps	Lagging by 40 (±10)	Lagging by 30 (±10)

37. Adjust servo analyzer to obtain 0.5 volt ac at P1-A (Hi) and P1-B (Lo).
38. Set PHASE LAG control on servo analyzer to 0 (± 2) degrees.
39. Read and record dc voltage at P1-U (+) and P1-V (-). Voltage shall be 27 (± 2) volts.
40. Set PHASE LAG control on servo analyzer to 180 (± 2) degrees.
41. Read and record dc voltage at P1-U (+) and P1-V (-). Voltage shall be 27 (±2) volts.
42. Dismantle test setup.

C. CALCULATIONS: NA

D. RESULTS: NA



Zero Phase Shift Pattern

JOB: CALIBRATION OF PHASE SENSITIVE ERROR DETECTOR	**JDC** 19168 (Sheet 1 of 3)
SUBSYSTEM: OPTICS-INERTIAL ANALYZER	60 A11A2, 60 A1145, **ASSEMBLY:** and 60 A1148
DESCRIPTION: Procedure to check and adjust signal levels at which error detection operates.	**TYPE:** Calibrate **INTERVAL:** 90 days
TOOLS AND MATERIAL: See below.	**REFERENCES:** ATP 1900320 Sch 1900319 Wire list 1900322
IMPORTANT: None	

TOOLS AND MATERIALS

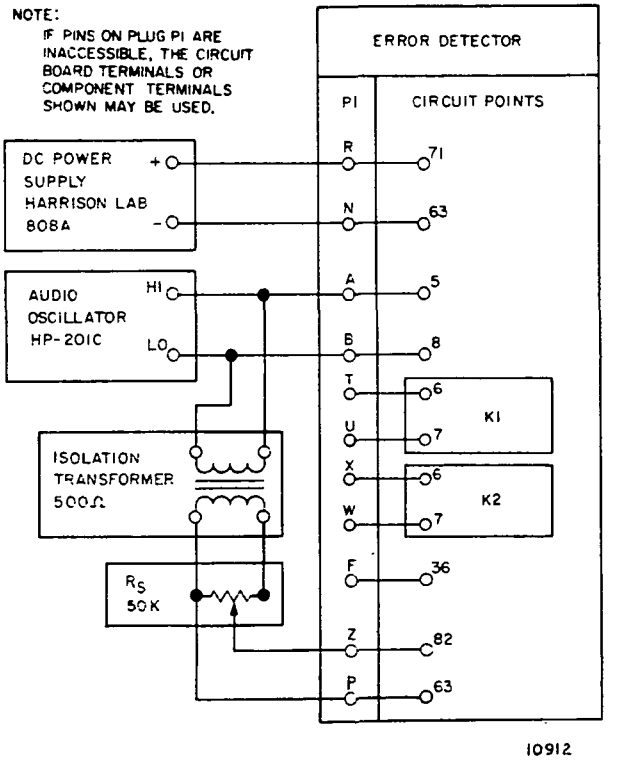
1. DC voltohmmeter, Simpson 269
2. Audio oscillator, HP-201C
3. DC power supply, Harrison Lab 808A
4. Differential voltmeter, Fluke 803
5. Isolation transformer, 1:1
6. Potentiometer, 50,000 ohms

A. PREPARATION: NA

B. PROCEDURE:

CAUTION: Equipment must be turned off whenever any power connections are being made.

1. Establish test setup as shown.
   NOTE: To obtain maximum accuracy from test equipment during the following procedures, 30 minutes warmup time must be allowed.
   NOTE: Use dc voltohmmeter to make all dc voltage measurements in the following steps.
2. Set dc power supply to 30 (±1) volts.
3. Set audio oscillator output to 28 (±0.056) volts, 800 (±8) cps.



Test Setup

4. Connect differential voltmeter to P1-Z (Hi) and P1-P (Lo).
5. Adjust potentiometer R_s until differential voltmeter indicates 1.55 (±0.005) volts.
6. Set dc voltohmmeter to measure resistance and connect to P1-X and P1-U.

NOTE: Unless otherwise specified, a zero indication on the dc voltohmmeter indicates that relay being checked is energized.

7. Adjust potentiometer R2 until relay K1 energizes.
8. Reverse leads between audio oscillator and isolation transformer.
9. Adjust potentiometer R_s until differential voltmeter indicates 1 (±0.005) volts.
10. Disconnect dc voltohmmeter from P1-X and P1-U and connect to P1-V and P1-W.
11. Adjust potentiometer R_s in an increasing direction until relay K2 energizes.
12. Read and record differential voltmeter indication at which relay K2 energized.
13. Determine value of expression $\frac{V_1 - V_2}{2} + V_1$, where V_1 = voltage specified in step 5, and V_2 = voltage recorded in step 12.
14. Reverse leads between audio oscillator and isolation transformer.
15. Adjust potentiometer R_s until differential voltmeter indication is within 0.005 volt of value calculated in step 13.
16. Disconnect dc voltohmmeter from P1-V and P1-W and connect to P1-X and P1-U.
17. Starting fully counterclockwise, adjust potentiometer R2 clockwise until relay K1 energizes.
18. Adjust potentiometer R_s in a decreasing direction until relay K1 deenergizes.
19. Read and record differential voltmeter indication. Voltmeter indication shall be within 0.03 volt or value calculated in step 13.
20. Determine value of expression $\frac{V_1 - V_2}{2} + V_2$, where V_1 = voltage specified in step 5, and V_2 = voltage recorded in step 12.
21. Disconnect dc voltohmmeter from P1-X and P1-U and connect to P1-V and P1-W.
22. Reverse leads between audio oscillator and isolation transformer.
23. Adjust potentiometer R_s until differential voltmeter indicates 2 (±0.005) volts. Relay K2 shall energize.
24. Adjust potentiometer R_s in a decreasing direction until relay K2 deenergizes.
25. Read and record differential voltmeter indication. Voltmeter indication shall be within 0.03 volt of value calculated in step 20.
26. Adjust potentiometer R_s until differential voltmeter indicates 2 (± 0.005) volts. Relay K2 shall energize.
27. Adjust potentiometer R_s until differential voltmeter indicates 28 volts. Relay K2 shall remain energized.
28. Reverse leads between audio oscillator

and isolation transformer.

29. Disconnect dc voltohmmeter from P1-V and P1-W and connect to P1-U and P1-X.

30. Adjust potentiometer R_s until differential voltmeter indicates 3 (± 0.005) volts. Relay K1 shall energize.

31. Adjust potentiometer R_s until differential voltmeter indicates 28 volts. Relay K1 shall remain energized.

32. Disconnect potentiometer R_s and differential voltmeter from P1-Z and connect to P1-F.

33. Reverse leads between audio oscillator and isolation transformer.

34. Disconnect dc voltohmmeter from P1-U and P1-X and connect to P1-V and P1-T.

35. Adjust potentiometer R_s until differential voltmeter indicates 15 (± 1) volts. Relays K1 and K2 shall remain deenergized (0 indication on dc voltohmmeter).

36. Disconnect dc voltohmmeter from P1-V and P1-T and connect to P1-X and P1-U.

37. Reverse leads between audio oscillator and isolation transformer. Relay K1 shall energize.

38. Dismantle test setup.

C. CALCULATIONS: NA

D. RESULTS: NA

JOB: CALIBRATION OF GIMBAL DUMP PROTECTION ASSEMBLY	**JDC** 19169 (Sheet 1 of 3)
SUBSYSTEM: OPTICS-INERTIAL ANALYZER	60 A11A1, 60 A11A4, **ASSEMBLY:** and 60 A1147
DESCRIPTION: Procedure to check and adjust assembly.	**TYPE:** Calibrate **INTERVAL:** 90 days
TOOLS AND MATERIAL: 1. Power supply, Harrison Lab 808A 2. Counter, CMC 727B 3. Differential voltmeter, Fluke 803 4. Voltohmmeter, Simpson 269	**REFERENCES:** ATP 1900269 Sch 1900176 Wire list 1900317 Wire list 1900318
IMPORTANT: None	

A. PREPARATION:

NOTE: To obtain maximum accuracy from test equipment during the following procedures, 30 minutes warmup time must be allowed.

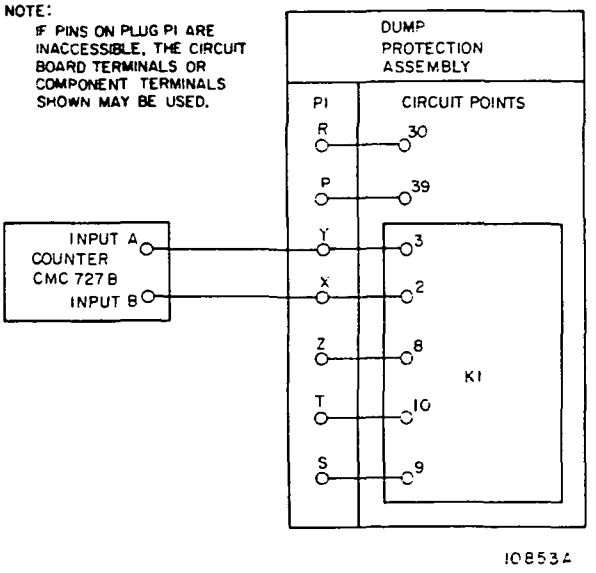
NOTE: Unless otherwise specified, use differential voltmeter to make all dc voltage measurements in the following steps.

1. Set power supply output to 28 (±0.28) volts dc.
2. To stabilize capacitors, apply power supply output to P1-R(+) and P1-P(-) for five minutes and to P1-P(+) and P1-R(-) for five minutes.

B. PROCEDURE:

CAUTION: Equipment must be turned off whenever any power connections are being made.

1. Establish test setup as shown.
2. Reset relay K1 by momentarily applying power supply output to P1-S(+) and P1-T(-).



Test Setup

3. Connect jumper between P1-Z and P1-R.
   NOTE: In the following steps allow a minimum of 30 seconds between relay K1 reset and time delay measurements.
4. Apply power supply output to P1-R(+) and P1-P(-) until relay K1 energizes.
5. Read and record time delay displayed on counter. Time delay shall be as specified in table.
6. Reset relay K1.
   NOTE: To increase time delay, adjust potentiometer R9 counterclockwise; to decrease time delay, adjust potentiometer R9 clockwise.
7. If necessary, adjust potentiometer R9 to obtain time delay as specified in table. Measure and record time delay (steps 4, 5, and 6) after any adjustment of potentiometer R9.
8. Move jumper from P1-R to P1-P.
9. Apply power supply output to P1-P(+) and P1-R(-) until relay K1 energizes.
10. Read and record time delay displayed on counter. Time delay shall be as specified in table.
11. Reset relay K1.
12. If necessary, adjust potentiometer R9 to obtain time delay as specified in table. Measure and record time delay (steps 9, 10, and 11) after any adjustment of potentiometer R9.
13. If any adjustment of potentiometer R9 was made in step 12, move jumper from P1-P to P1-R and repeat steps 4, 5, and 6 to insure that time delay obtained in first reading was not disturbed.
14. Set power supply output to 20 (±0.2) volts dc.
15. Move jumper from P1-P to P1-R.
16. Apply power supply output to P1-R(+) and P1-P(-) until relay K1 energizes.
17. Read and record time delay displayed on counter. Time delay shall be as specified in table.

Table of Delay Times

Assembly Circuit	Delay Time	
	± 28 volts dc applied	± 20 volts dc applied
Inner gimbal (1900269-011)	0.162 (±0.0081) seconds	0.265 (±0.0265) seconds
Middle gimbal (1900269-021)	0.770 (±0.0385) seconds	1.250 (±0.125) seconds
Outer gimbal (1900269-031)	1.600 (±0.08) seconds	2.610 (±0.261) seconds

18. Reset relay K1.
19. Move jumper from P1-R to P1-P.
20. Apply power supply output to P1-P(+) and P1-R(-) until relay K1 energizes.
21. Read and record time delay displayed on counter. Time delay shall be as specified in table.
22. Reset relay K1.
23. Disconnect counter from assembly and remove jumper from P1-Z and P1-P.
24. Connect voltohmmeter to check continuity between P1-Z and P1-X. Voltohmmeter shall indicate open circuit.
25. Set power supply output to 10 (±0.1) volts dc.
26. Connect power supply output to P1-R(+) and P1-P(-).
27. Increase power supply output in 0.1-volt increments at 5-second intervals until relay K1 closes (zero indication on voltohmmeter).
28. Measure and record power supply output voltage. Voltage shall be 11.6 (±1.16) volts dc.
29. Reduce power supply voltage to 10.0 volts.
30. Reset relay K1.
31. Reverse dc power supply connections (+ to P1-P, - to P1-R).
32. Increase dc power supply voltage in 0.1-volt increments at 5-second intervals until relay K1 closes (zero indication on voltohmmeter).
33. Measure and record power supply output voltage. Voltage shall be 11.6 (±1.16) volts dc.
34. Dismantle test setup.

C. CALCULATIONS: NA

D. RESULTS: NA

JOB: CALIBRATION OF GIMBAL POSITION DISPLAY 1-SPEED RESOLVER	**JDC** 19170 (Sheet 1 of 2)
SUBSYSTEM: OPTICS-INERTIAL ANALYZER	**ASSEMBLY:** 60 A11A9, 60 A11A10, and 60 A11A11
DESCRIPTION: Procedure to check and zero 1-speed resolver.	**TYPE:** Calibrate **INTERVAL:** 90 Days
TOOLS AND MATERIAL: 1. Audio oscillator, HP-201C 2. Differential voltmeter, Fluke 803	**REFERENCES:** ATP 1900300 Sch 1900286 Mech sch 1900395
IMPORTANT: None	

A. PREPARATION: NA

B. PROCEDURE:

CAUTION: Equipment must be turned off whenever any power connections are being made.

NOTE: To obtain maximum accuracy from test equipment during the following procedures, 30 minutes warmup time must be allowed.

1. Connect audio oscillator to J1-F (Hi) and J1-E (Lo).
2. Set gimbal position display to 0 degree 0 minute.

NOTE: Check gimbal position display readout periodically to insure that readout remains at 0 degree 0 minute until step 11 is completed.

3. Connect jumper to J1-B and J1-F.
4. Connect differential voltmeter to J1-A (Hi) and J1-E (Lo).
5. Set audio oscillator output to 28 (±1.5) volts, 800 (±5) cps.
6. Loosen 1-speed resolver case.
7. Rotate 1-speed resolver case for maximum reading on differential voltmeter.
8. Disconnect differential voltmeter and jumper.
9. Connect differential voltmeter to J1-A (Hi) and J1-B (Lo).
10. Rotate 1-speed resolver case approximately 90 degrees clockwise for null on differential voltmeter.
11. Clamp 1-speed resolver case while maintaining null.
12. Set gimbal position display to 170 degrees.

NOTE: Final adjustment in step 13 must be made in an increasing direction.

13. Using FINE ADJUST control, obtain null on differential voltmeter at approximately 180 degrees.
14. Record reading on gimbal position display.
15. Set gimbal position display to 190 degrees.

NOTE: Final adjustment in step 16 must be made in a decreasing direction.

16. Using FINE ADJUST control, obtain null on differential voltmeter at approximately 180 degrees.

17. Record reading on gimbal position display.

18. Difference between readings in steps 14 and 17 shall not exceed 47 minutes.

19. Set gimbal position display to 10 degrees.

NOTE: Final adjustment in step 20 must be made in a decreasing direction.

20. Using FINE ADJUST control, obtain null on differential voltmeter at approximately 0 degree.

21. Record reading on gimbal position display.

22. Set gimbal position display to 350 degrees.

NOTE: Final adjustment in step 23 must be made in an increasing direction.

23. Using FINE ADJUST control, obtain null on differential voltmeter at approximately 0 degree.

24. Record reading on gimbal position display.

25. Difference between readings in steps 21 and 24 shall not exceed 47 minutes.

26. Dismantle test setup.

C. CALCULATIONS: NA

D. RESULTS: NA

JOB: CALIBRATION OF GIMBAL POSITION DISPLAY 16-SPEED RESOLVER	**JDC** 19171 (Sheet 1 of 2)
SUBSYSTEM: OPTICS-INERTIAL ANALYZER	**ASSEMBLY:** 60 A11A9, 60 A11A10, and 60 A11A11
DESCRIPTION: Procedure to check and zero 16-speed resolver.	**TYPE:** Calibrate **INTERVAL:** 90 Days
TOOLS AND MATERIAL: 1. Audio oscillator, HP-201C 2. Differential voltmeter, Fluke 803	**REFERENCES:** ATP 1900300 Sch 1900286 Mech sch 1900395
IMPORTANT: None	

A. PREPARATION: NA

B. PROCEDURE:

CAUTION: Equipment must be turned off whenever any power connections are being made.

NOTE: To obtain maximum accuracy from the test equipment during the following procedures, 30 minutes warmup time must be allowed.

1. Connect audio oscillator to J2-F (Hi) and J2-E (Lo).
2. Set gimbal position display to 0 degrees 0 minutes.

NOTE: Check gimbal position display readout periodically to insure that readout remains at 0 degrees 0 minutes until step 11 is completed.

3. Connect jumper to J2-B and J2-F.
4. Connect differential voltmeter to J2-A (Hi) and J2-E (Lo).
5. Set audio oscillator output to 28 (±1.5) volts, 800 (±5) cps.
6. Loosen 16-speed resolver case.
7. Rotate 16-speed resolver case for maximum reading on differential voltmeter.
8. Disconnect differential voltmeter and jumper.
9. Connect differential voltmeter to J2-A (Hi) and J2-B (Lo).
10. Rotate 16-speed resolver case approximately 90 degrees clockwise for null on differential voltmeter.
11. Clamp 16-speed resolver case while maintaining null.
12. Set gimbal position display to 8 degrees.

NOTE: Final adjustment in step 13 must be made in an increasing direction.

13. Using FINE ADJUST control, obtain null on differential voltmeter at approximately 11 degrees 15 minutes.
14. Record reading on gimbal position display.

15. Set gimbal position display to 15 degrees.

NOTE: Final adjustment in step 16 must be made in a decreasing direction.

16. Using FINE ADJUST control, obtain null on differential voltmeter at approximately 11 degrees 15 minutes.

17. Record reading on gimbal position display.

18. Difference between readings in step 14 and step 17 shall not exceed 3 minutes.

NOTE: Final adjustment in step 19 must be made in a decreasing direction.

19. Using FINE ADJUST control, obtain null on differential voltmeter at approximately 0 degrees.

20. Record reading on gimbal position display.

21. Set gimbal position display to 355 degrees.

NOTE: Final adjustment in step 22 must be made in an increasing direction.

22. Using FINE ADJUST control, obtain null on differential voltmeter at approximately 0 degrees.

23. Record reading on gimbal position display.

24. Difference between readings in step 20 and step 23 shall not exceed 3 minutes.

25. Dismantle test setup.

C. CALCULATIONS: NA

D. RESULTS: NA

JOB: CALIBRATION OF OSCILLOGRAPH SIGNAL SELECTOR	**JDC** 19180 (Sheet 1 of 3)
SUBSYSTEM: OPTICS-INERTIAL ANALYZER	**ASSEMBLY:** 60 A26
DESCRIPTION: Procedure to check and adjust panel operation.	**TYPE:** Calibrate **INTERVAL:** 90 Days
TOOLS AND MATERIAL: 1. Audio oscillator, HP-201C 2. DC power supply, Harrison Lab 808A (2 required) 3. Phase angle voltmeter, Gertsch PAV-2 4. Decade resistance box, Clarostat 240C	**REFERENCES:** ATP 1900056A Sch 1900648
IMPORTANT: JDC's 19191, 19192, 19193, and 19194 must be completed before performing this job.	

A. PREPARATION: NA

B. PROCEDURE:

CAUTION: Equipment must be turned off whenever power connections are being made.

1. Establish test setup as shown.

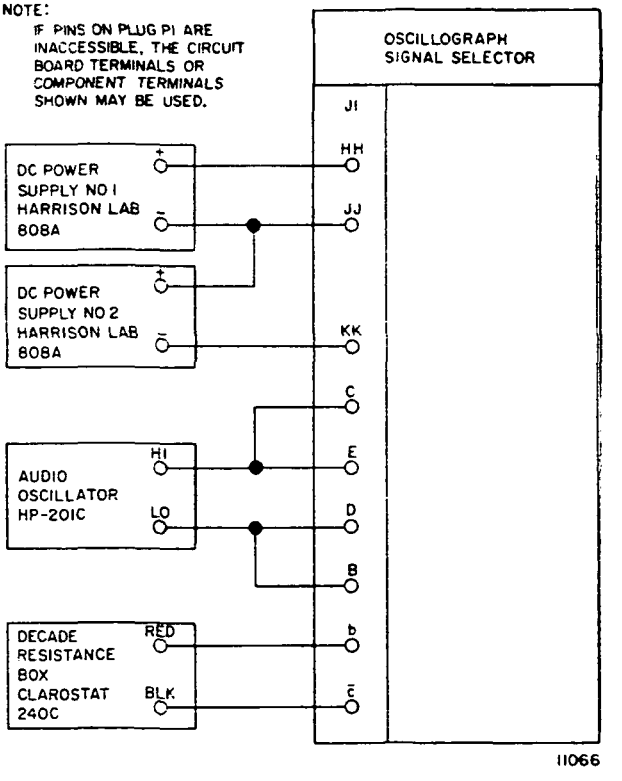
NOTE: To obtain maximum accuracy from test equipment during the following procedures, 30 minutes warmup time must be allowed.

2. Set decade resistance box to 1000 ohms.

NOTE: Unless otherwise specified, use differential voltmeter to make all voltage measurements in the following steps.

3. Set dc power supply no. 1 to 30 (±1.5) volts.

4. Set dc power supply no. 2 to 30 (±1.5) volts.



Test Setup

5. Set audio oscillator to 28 (±0.28) volts, 800 (±8) cps.
6. Read and record ac voltage at pins J1-b (Hi) and J1-c (Lo). Voltage shall be 28 (±1) volts.
7. Use phase angle voltmeter to measure phase angle between the input [J1-E (Hi) and J1-D (Lo)] and the output [J1-b (Hi) and J1-c (Lo)].
8. Read and record phase angle voltmeter indication. Phase angle shall be 0 (±1.5) degrees.
9. Read and record ac voltage at J1-d (Hi) and J1-e (Lo). Voltage shall be 11 (±0.5) volts.
10. Use phase angle voltmeter to measure phase angle between the input [J1-E (Hi) and J1-D (Lo)] and the output [J1-d (Hi) and J1-e (Lo)].
11. Read and record phase angle voltmeter indication. Phase angle shall be 90 (±2) degrees.
12. Read and record ac voltage at J1-H (Hi) and J1-J (Lo). Voltage shall be 28 (±1) volts.
13. Use phase angle voltmeter to measure phase angle between the input [J1-C (Hi) and J1-B (Lo)] and the output [J1-H (Hi) and J1-J (Lo)].
14. Read and record phase angle voltmeter indication. Phase angle shall be 0 (±1.5) degrees.
15. Read and record ac voltage at J1-K (Hi) and J1-L (Lo). Voltage shall be 11 (±0.5) volts.
16. Use phase angle voltmeter to measure phase angle between the input [J1-C (Hi) and J1-B (Lo)] and the output [J1-K (Hi) and J1-L (Lo)].
17. Read and record phase angle voltmeter indication. Phase angle shall be 90 (±2) degrees.
18. Press ISS 800~ TO PH GEN switch.
19. Set PHASE GENERATOR 800 CPS control to 0 degree.
20. Read and record ac voltage at J1-f (Hi) and J1-g (Lo). Voltage shall be 28 (±1) volts.
21. If necessary, adjust potentiometer R1 until voltmeter indicates 28 (±1) volts ac at J1-f (Hi) and J1-g (Lo).
22. Use phase angle voltmeter to measure phase angle between the ISS 800-cps, 0-phase amplifier output [J1-H (Hi) and J1-J (Lo)] and the phase generator amplifier output [J1-f (Hi) and J1-g (Lo)].
23. Read and record phase angle voltmeter indication. Phase angle shall be 0 (±1) degrees.
24. If necessary, adjust PHASE GENERATOR 800 CPS control until phase angle voltmeter indicates 0 (±1) degrees.
25. Read and record PHASE GENERATOR 800 CPS control setting.
26. Disconnect audio oscillator from J1-B, J1-C, J1-D, and J1-E, and connect to J1-G (Hi) and J1-F (Lo).
27. Set audio oscillator output to 2 volts, 3200 cps.
28. Read and record ac voltage at J1-h (Hi)

and J1-j (Lo). Voltage shall be 11 (±0.5) volts.

29. Use phase angle voltmeter to measure phase angle between the input [J1-G (Hi) and J1-F (Lo)] and the output [J1-h (Hi) and J1-j (Lo)].

30. Read and record phase angle voltmeter indication. Phase angle shall be 0 (±1.5) degree.

31. Set PHASE GENERATOR 3200 CPS control to 0 degrees.

32. Read and record ac voltage at J1-w (Hi) and J1-x (Lo). Voltage shall be 11 (±0.5) volts.

33. If necessary, adjust potentiometer R7 in phase generator amplifier (A14) until voltmeter indicates 11 (±0.5) volts at J1-w (Hi) and J1-x (Lo).

34. Use phase angle voltmeter to measure phase angle between ISS 3200-cps amplifier output [J1-h (Hi) and J1-j (Lo)] and the phase generator amplifier output [J1-w (Hi) and J1-x (Lo)].

35. Read and record phase angle voltmeter indication. Phase angle shall be 0 (±1) degrees.

36. If necessary. adjust PHASE GENERATOR 3200 CPS control until phase angle voltmeter indicates 0 (±1) degrees.

37. Read and record PHASE GENERATOR 3200 CPS control setting.

38. Dismantle test setup.

C. CALCULATIONS: NA

D. RESULTS: NA

JOB: CALIBRATION OF BUFFER AMPLIFIER (PHASE GENERATOR)	**JDC** 19191 (Sheet 1 of 4)
SUBSYSTEM: OPTICS-INERTIAL ANALYZER	**ASSEMBLY:** 60 A26A14
DESCRIPTION: Procedure to check operation of and adjust buffer amplifier.	**TYPE:** Calibrate **INTERVAL:** 90 Days.
TOOLS AND MATERIAL: See below.	**REFERENCES:** ATP 1900132 Sch 1900129 Wire harness 1900135
IMPORTANT: None	

TOOLS AND MATERIAL:

1. Audio oscillator, HP-201C
2. DC power supply, Harrison Lab 808A
3. Oscilloscope, Tektronix 545A
4. Vacuum tube voltmeter, HP-400H
5. Phase angle voltmeter, GertschPAV-2
6. Decade resistance box, 240C (2 required)
7. Differential voltmeter, Fluke 803

A. PREPARATION: NA

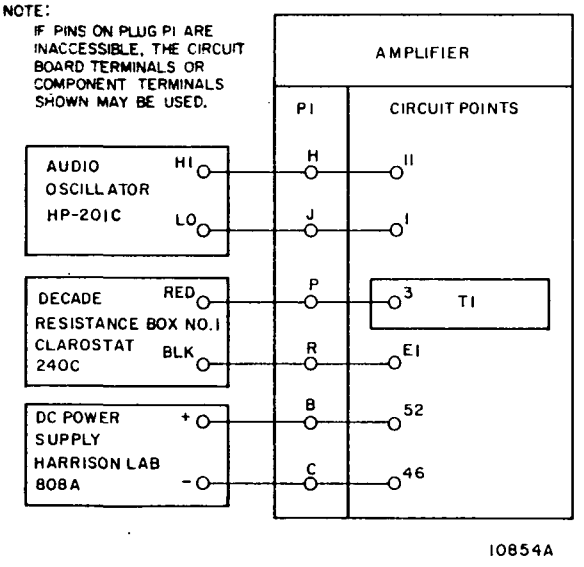
B. PROCEDURE:

CAUTION: Equipment must be turned off whenever any power connections are being made.

1. Establish test setup as shown.

NOTE: To obtain maximum accuracy from test equipment during the following procedures, 30 minutes warmup time must be allowed.

2. Set decade resistance box no. 1 to 20,000 ohms.



800-cps Test Setup

NOTE: Use differential voltmeter to make all voltage measurements in the following steps.

3. Set dc power supply output to 30 volts.
4. Set audio oscillator output to 10.5 (±0.1) volts, 800 (±16) cps.
5. Set potentiometer R1 fully clockwise.
6. Read and record ac voltage at P1-H (Hi) and P1-J (Lo).
7. Read and record ac voltage at P1-P (Hi) and P1-R (Lo).
8. Divide reading in step 7 by reading in step 6.
9. Read and record ratio (gain) obtained in step 8. Gain shall be greater than 3.
10. Set potentiometer R1 fully counterclockwise.
11. Read and record ac voltage at P1-P (Hi) and P1-R (Lo).
12. Divide reading in step 11 by reading in step 6.
13. Record gain obtained in step 12. Gain shall be less than 2.3.
14. Adjust potentiometer R1 until voltmeter indicates 28 volts ac at P1-P (Hi) and P1-R (Lo).
15. Using phase angle voltmeter, measure phase angle between the input [P1-H (Hi) and P1-J (Lo)] and the output [P1-P (Hi) and P1-R (Lo)].
16. Read and record phase angle voltmeter indication. Phase angle shall be 0 (±2) degrees.
17. Disconnect decade resistance box no. 1.
18. Read and record phase angle voltmeter indication. Phase angle shall be within one degree of phase angle recorded in step 16.
19. Reconnect decade resistance box no. 1 to P1-P and P1-R.
20. Set decade resistance box no. 2 to zero ohms.
21. Insert decade resistance box no. 2 between P1-H and the audio oscillator Hi terminal.
22. Set audio oscillator output to 10.5 (±0.1) volts, 800 (±16) cps.
23. Set decade resistance box no. 2 to 5000 ohms.
24. Measure and record voltage across decade resistance box no. 2. Voltage shall be 2.1 (±0.2) volts ac.
25. Remove decade resistance box no. 2 from test setup.
26. Reconnect audio oscillator Hi terminal to P1-H.
27. Adjust audio oscillator output until voltmeter indicates 30 (±0.3) volts ac at P1-P (Hi) and P1-R (Lo).
28. Connect oscilloscope to P1-P (Hi) and P1-R (Lo). Waveform on oscilloscope shall not be clipped.
29. Dismantle 800-cps test setup.
30. Establish 3200-cps test setup as shown.
31. Set decade resistance box no. 1 to 20,000 ohms.
32. Set dc power supply to 30 volts.
33. Set audio oscillator output to 4 (±0.04) volts, 3200 (±32) cps.
34. Set potentiometer R7 fully clockwise.

35. Read and record ac voltage at P1-E (Hi) and P1-F (Lo).

36. Read and record ac voltage at P1-M (Hi) and P1-N (Lo).

37. Divide reading in step 36 by reading in step 35.

38. Record ratio (gain) obtained in step 37. Gain shall be greater than 3.05.

39. Set potentiometer R7 fully counterclockwise.

40. Read and record ac voltage at P1-M (Hi) and P1-N (Lo).

41. Divide reading in step 40 by reading in step 35.

42. Record ratio (gain) obtained in step 41. Gain shall be less than 2.3.

43. Adjust potentiometer R7 until voltmeter indicates 11 volts ac at P1-M (Hi) and P1-N (Lo).

44. Using phase angle voltmeter, measure phase angle between the input, [P1-E (Hi) and P1-F (Lo)], and the output, [P1-M (Hi) and P1-N (Lo)].

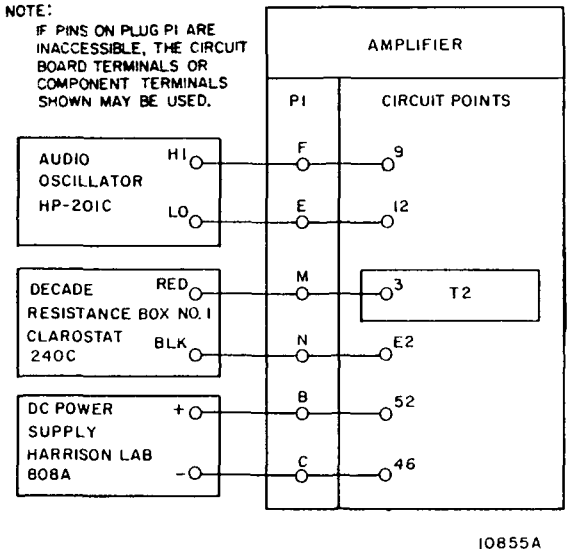
45. Read and record phase angle voltmeter indication. Phase angle shall be 0 (±2) degrees.

46. Disconnect decade resistance box no. 1.

47. Read and record phase angle voltmeter indication. Phase angle shall be within one degree of the phase angle recorded in step 45.

48. Reconnect decade resistance box no. 1 to P1-M and P1-N.

49. Set decade resistance box no. 2 to 0 ohms.



3200-cps Test Setup

50. Insert decade resistance box no. 2 between P1-F and the audio oscillator Hi terminal.
51. Set audio oscillator output to 4 volts, 3200 (±32) cps.
52. Set decade resistance box no. 2 to 5000 ohms.
53. Measure and record voltage across decade resistance box no. 2. Voltage shall be 2.02 (±0.2) volts ac.
54. Remove decade resistance box no. 2 from test setup.
55. Reconnect audio oscillator Hi terminal to P1-F.
56. Adjust audio oscillator output to obtain 13 (±0.1) volts, 3200 (±32) cps between P1-M (Hi) and P1-N (Lo).
57. Connect oscilloscope to P1-M (Hi) and P1-N (Lo). Waveform on oscilloscope shall not be clipped.
58. Dismantle test setup.

C. CALCULATIONS: NA

D. RESULTS: NA

JOB: TEST OF BUFFER AMPLIFIER (800-CPS, π/2-PHASE)	**JDC** 19192 (Sheet 1 of 2)
SUBSYSTEM: OPTICS-INERTIAL ANALYZER	**ASSEMBLY:** 60 A26A12 and 60 A26A9
DESCRIPTION: Procedure to check operational characteristics of buffer amplifier.	**TYPE:** Test **INTERVAL:** 90 Days
TOOLS AND MATERIAL: See below.	**REFERENCES:** ATP 1900138 Sch 1900131 Wire harness 1900139
IMPORTANT: None	

TOOLS AND MATERIAL:

1. Audio oscillator, HP-201C
2. DC power supply, Harrison Lab 808A (2 required)
3. Oscilloscope, Tektronix 545A
4. Differential voltmeter, Fluke 803
5. Phase angle voltmeter, Gertsch PAV-2
6. Spectrum analyzer, HP-302A
7. Decade resistance box, Clarostat 240C (2 required)
8. Decade capacitance box, General Radio 1419B

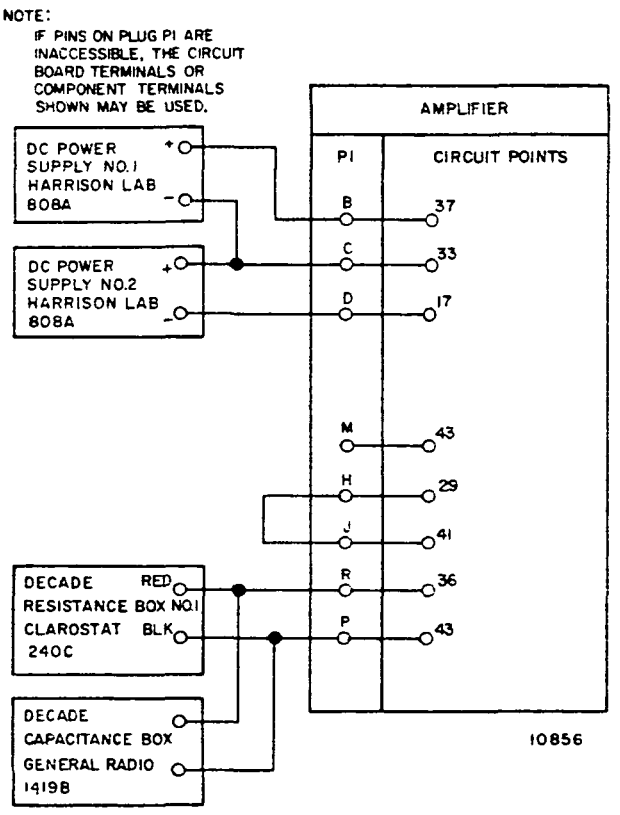
A. PREPARATION: NA

B. PROCEDURE:

CAUTION: Equipment must be turned off whenever any power connections are being made.

1. Establish test setup as shown.

NOTE: To obtain maximum accuracy from test equipment during the following procedures, 30 minutes warmup time must be allowed.



Test Setup

2. Set decade resistance box no. 1 to 4000 ohms.
3. Set decade capacitance box to 4700 micromicrofarads.

NOTE: Use differential voltmeter to make all voltage measurements, including oscillation level, in the following steps.

4. Set dc power supply no. 1 to 30 (±0.3) volts.
5. Set dc power supply no. 2 to 30 (±0.3) volts.
6. Read and record oscillation level at P1-M (Hi) and P1-C (Lo). Oscillation level shall be less than 100 millivolts.
7. Disconnect jumper from P1-H and P1-J.
8. Connect audio oscillator to P1-H (Hi) and P1-J (Lo).
9. Set audio oscillator to 800 (±16) cps.
10. Set audio oscillator output to 29 (±1) volts.
11. Connect phase angle voltmeter as required to measure phase angle between the input [P1-H (Hi) and P1-J (Lo)] and the output [P1-M (Hi) and P1-C (Lo)].
12. Read and record phase angle voltmeter indication. Phase angle shall be 90 (±1.5) degrees.
13. Disconnect phase angle voltmeter.
14. Read and record ac voltage at P1-H (Hi) and P1-J (Lo).
15. Read and record ac voltage at P1-M (Hi) and P1-C (Lo).
16. Divide reading in step 15 by reading in step 14.
17. Record gain obtained in step 16. Gain shall be 0.39 (±0.0078).
18. Using spectrum analyzer, measure distortion of signal at P1-M (Hi) and P1-C (Lo). Record percentage of distortion. Distortion shall be less than 1 percent.
19. Set audio oscillator output to 30 volts.
20. Connect oscilloscope to P1-M (Hi) and P1-C (Lo). Output shall not be clipped.
21. Set decade resistance box no. 2 to 0 ohms.
22. Connect decade resistance box no. 2 in series with audio oscillator hi terminal and P1-H.
23. Set audio oscillator output to 29 (±1) volts.
24. Set decade resistance box no. 2 to 5000 ohms.
25. Measure and record voltage drop across decade resistance box no. 2. Voltage shall be less than 2.9 volts.
26. Dismantle test setup.

C. CALCULATIONS: NA

D. RESULTS: NA

JOB: TEST OF BUFFER AMPLIFIER (800-CPS, 0-PHASE)	**JDC** 19193 (Sheet 1 of 3)
SUBSYSTEM: OPTICS-INERTIAL ANALYZER	**ASSEMBLY:** 60 A26A10 60 A26A13
DESCRIPTION: Procedure to check the operational characteristics of buffer amplifier.	**TYPE:** Test **INTERVAL:** 90 Days
TOOLS AND MATERIAL: See below.	**REFERENCES:** Sch 1900130 ATP 1900181 Wire harness 1900245
IMPORTANT: None	

TOOLS AND MATERIAL:

1. Audio oscillator, HP-201C
2. DC power supply, Harrison Lab 808A
3. Oscilloscope, Tektronix 545A
4. Differential voltmeter, Fluke 803
5. Phase angle voltmeter, Gertsch PAV-2
6. Spectrum analyzer, HP-302A
7. Decade resistance box, Clarostat 240C (2 required)
8. Decade capacitance box, General Radio 1419B
9. Decade inductance box, General Radio 1490

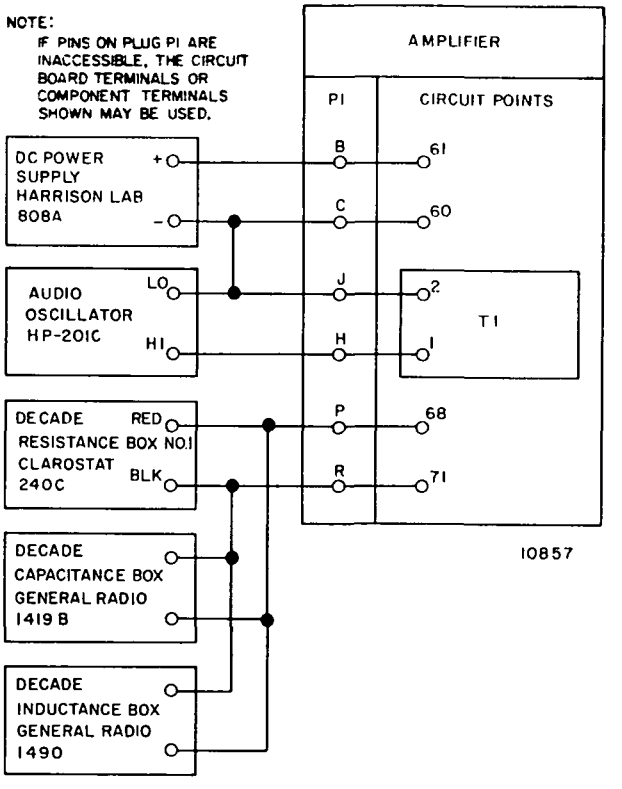
A. PREPARATION: NA

B. PROCEDURE:

CAUTION: Equipment must be turned off whenever any power connections are being made.

1. Establish test setup as shown.

NOTE: To obtain maximum accuracy from test equipment during the following procedures,



Test Setup

30 minutes warmup time must be allowed.

2. Set decade resistance box no. 1 to 1000 ohms.
3. Set decade inductance box to 500 millihenrys.
4. Set decade capacitance box to 0.01 microfarad.
5. Set audio oscillator output to 28 volts, 800 (±8) cps.

NOTE: Use Fluke 803 differential voltmeter to make all voltage measurements in the following steps.

6. Set dc power supply to 30 volts.
7. Connect phase angle voltmeter as required to measure phase angle between the input, [P1-H (Hi) and P1-J (Lo)], and the output, [P1-P (Hi) and P1-R (Lo)].
8. Read and record phase angle voltmeter indication. Phase angle shall be 0 (±1) degrees.
9. Disconnect phase angle voltmeter.
10. Read and record ac voltage at P1-H (Hi) and P1-J (Lo).
11. Read and record ac voltage at P1-P (Hi) and P1-R (Lo).
12. Divide reading in step 11 by reading in step 10.
13. Record gain calculated in step 12. Gain shall be 1.00 (±0.01).
14. Using spectrum analyzer, measure distortion of signal at P1-P (Hi) and P1-R (Lo). Record percentage of distortion. Distortion shall be less than 1 percent.
15. Set decade resistance box no. 1 to 700 ohms.
16. Set decade inductance box to 100 millihenrys.
17. Set audio oscillator output to 30 volts, 800 (±8) cps.
18. Connect oscilloscope to P1-P (Hi) and P1-R (Lo). Sine wave as viewed on oscilloscope shall not be clipped.
19. Disconnect oscilloscope.
20. Set audio oscillator output to 28 volts, 800 (±8) cps.
21. Repeat steps 7 through 14.
22. The two values recorded in step 13 shall agree within 1 percent.
23. Set decade resistance box no. 1 to 1500 ohms.
24. Repeat steps 7 through 14.
25. The three values recorded in step 13 shall agree within 1 percent.
26. Set decade resistance box no. 2 to 0 ohms.
27. Insert decade resistance box no. 2 between audio oscillator Hi terminal and P1-H.
28. Check that audio oscillator output is 28 volts, 800 (±8) cps.
29. Set decade resistance box no. 2 to 5000 ohms.
30. Measure and record voltage drop across decade resistance box no. 2. Voltage shall be 1.75 volts maximum.
31. Disconnect audio oscillator and decade resistance box no. 2.
32. Set decade resistance box no. 1 to 700 ohms.

33. Connect jumper to P1-H and P1-J.
34. Read and record differential voltmeter indication at P1-P (+) and P1-R (-). Voltmeter shall indicate less than 50 millivolts.
35. Set decade resistance box no. 1 to 1500 ohms.
36. Read and record differential voltmeter indication at P1-P (+) and P1-R (-). Voltmeter shall indicate less than 50 millivolts.
37. Dismantle test setup.

C. CALCULATIONS: NA

D. RESULTS: NA

JOB: TEST OF BUFFER AMPLIFIER (3200-CPS)	**JDC** 19194 (Sheet 1 of 2)
SUBSYSTEM: OPTICS-INERTIAL ANALYZER	**ASSEMBLY:** 60 A26A11
DESCRIPTION: Procedure to check operating characteristics of buffer amplifier.	**TYPE:** Test **INTERVAL:** 90 Days
TOOLS AND MATERIAL: See below.	**REFERENCES:** ATP 1900140 Sch 1900128 Wire harness 1900246
IMPORTANT: None	

TOOLS AND MATERIAL:

1. Audio oscillator, HP-201C
2. DC power supply, Harrison Lab 808A (2 required)
3. Oscilloscope, Tektronix 545A
4. Differential voltmeter, Fluke 803
5. Phase angle voltmeter, Gertsch PAV-2
6. Spectrum analyzer, HP-302A
7. Decade resistance box, Clarostat 240C (2 required)
8. Decade capacitance box, General Radio 1419B

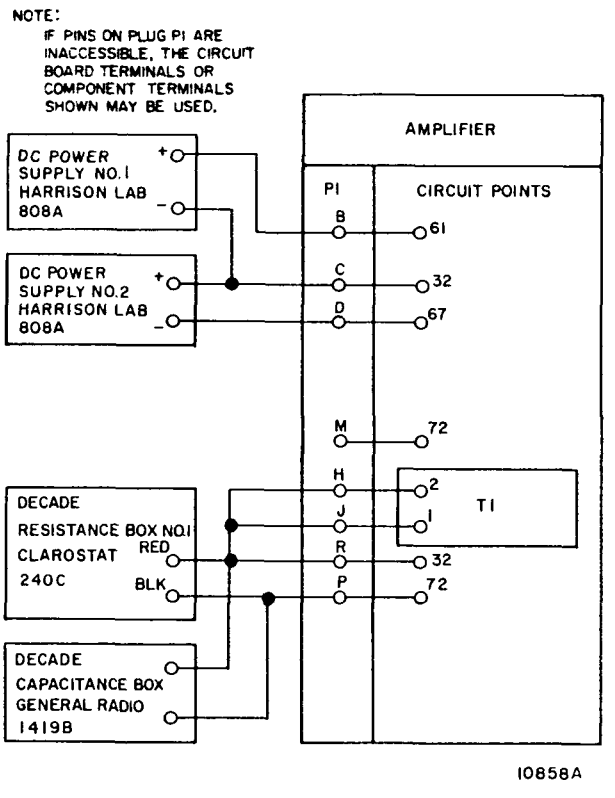
A. PREPARATION: NA

B. PROCEDURE:

CAUTION: Equipment must be turned off whenever any power connections are being made.

1. Establish test setup as shown.

NOTE: To obtain maximum accuracy from test equipment during the following procedures, 30 minutes warmup time must be allowed.



Test Setup

2. Set decade resistance box no. 1 to 3000 ohms.
3. Set decade capacitance box to 4700 micro-microfarads.

NOTE: Unless otherwise specified, use differential voltmeter to make all voltage measurements, including oscillation level, in the following steps.

4. Set dc power supply no. 1 to 30 (±0.3) volts.
5. Set dc power supply no. 2 to 30 (±0.3) volts.
6. Measure and record level of oscillation at P1-M (Hi) and P1-C (Lo). Oscillation shall be less than 100 millivolts.
7. Disconnect jumper between P1-H and P1-J.
8. Connect audio oscillator to P1-H (Hi) and P1-J (Lo).
9. Set audio oscillator output to 2 (±0.04) volts, 3200 (±64) cps.
10. Connect phase angle voltmeter as required to measure phase angle between the input [P1-H (Hi) and P1-J (Lo)] and the output [P1-P (Hi) and P1-R (Lo)].
11. Read and record phase angle voltmeter indication. Phase angle shall be 0 (±1) degrees.
12. Disconnect phase angle voltmeter.
13. Read and record ac voltage at P1-H (Hi) and P1-J (Lo).
14. Read and record ac voltage at P1-P (Hi) and P1-R (Lo).
15. Divide reading in step 14 by reading in step 13.
16. Record gain obtained in step 15. Gain shall be 5.5 (±0.11).
17. Use spectrum analyzer to measure distortion of output at P1-P (Hi) and P1-R (Lo).
18. Read and record percent of distortion. Distortion shall be less than 1 percent.
19. Connect oscilloscope to P1-P (Hi) and P1-R (Lo). Sine wave viewed on oscilloscope shall not be clipped.
20. Set decade resistance box no. 2 to 0 ohms.
21. Insert decade resistance box no. 2 in series with audio oscillator hi terminal and P1-H.
22. Check that audio oscillator output is 2 (±0.4) volts, 3200 (±64) cps.
23. Set decade resistance box no. 2 to 5000 ohms.
24. Read and record voltage drop across decade resistance box no. 2. Voltage shall be 0.1 volt or less.
25. Dismantle test setup.

C. CALCULATIONS: NA

D. RESULTS: NA

JOB: TEST OF POWER SUPPLY AND LOAD PANEL	**JDC** 19200 (Sheet 1 of 2)
SUBSYSTEM: OPTICS-INERTIAL ANALYZER	**ASSEMBLY:** 60 A7
DESCRIPTION: Procedure to check output of power supply and load panel.	**TYPE:** Test **INTERVAL:** 120 Days
TOOLS AND MATERIAL: See below.	**REFERENCES:** ATP 1900702 Sch 1900738
IMPORTANT: JDC's 19210 and 19211 must be performed prior to this job.	

TOOLS AND MATERIAL:

1. DC power supply, Trygon C36-50
2. Counter, CMC 727B
3. Vacuum tube voltmeter, HP-400H
4. Spectrum analyzer, HP-302A
5. Decade resistance box, Clarostat 240C (2)
6. DC voltohmmeter, HP 412A

A. PREPARATION: NA

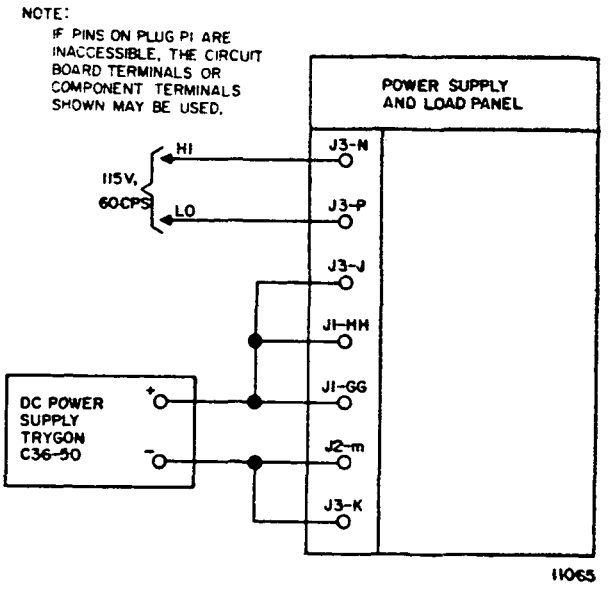
B. PROCEDURE:

CAUTION: Equipment must be turned off whenever any power connections are being made.

1. Establish test setup as shown.

NOTE: To obtain maximum accuracy from test equipment during the following procedures, 15 minutes warmup time must be allowed.

NOTE: Use dc voltohmmeter to make all dc voltage measurements in the following procedures.



Test Setup

2. Set dc power supply to 28 (±1.5) volts.
3. Read and record voltage and frequency of output at J2-f (Hi) and J1-Z (Lo) as measured with vacuum tube voltmeter and counter, respectively. Output shall be 4 (±1) volts, 3232 (±32) cps.
4. Read and record voltage, frequency, and distortion of output at J1-Y (Hi) and J1-Z (Lo) as measured with vacuum tube voltmeter, counter, and spectrum analyzer, respectively. Output shall be 2 (±0.1) volts, 3232 (±32) cps, with less than 3 percent distortion.
5. Read and record voltage, frequency, and distortion of output at J3-L (Hi) and J3-M (Lo) as measured with vacuum tube voltmeter, counter, and spectrum analyzer, respectively. Output shall be 115 (±5) volts, 400 (±15) cps, with less than 5 percent distortion.
6. Connect decade resistance box no. 1 to J3-L and J3-M.
7. Connect decade resistance box no. 2 to J2-n and J2-q.
8. Set decade resistance box no. 1 to 250 ohms.
9. Set decade resistance box no. 2 to 2500 ohms.
10. Read and record voltage, frequency, and distortion of output at J3-L (Hi) and J3-M (Lo) as measured with vacuum tube voltmeter, counter, and spectrum analyzer, respectively. Output shall be 115 (±5) volts, 400 (±15) cps, with less than 5 percent distortion.
11. Read and record voltage and frequency of outputs at J2-n (Hi) and J2-p (Lo) and at J2-q (Hi) and J2-p (Lo) as measured with vacuum tube voltmeter and counter, respectively. Both outputs shall be 108 (±10) volts and 400 (±15) cps.
12. Dismantle test setup.

C. CALCULATIONS: NA

D. RESULTS: NA

JOB: CALIBRATION OF 115-VOLT, 400-CPS POWER SUPPLY	**JDC** 19210 (Sheet 1 of 2)
SUBSYSTEM: OPTICS-INERTIAL ANALYZER	**ASSEMBLY:** 60 A7A1
DESCRIPTION: Procedure to check and adjust output of 115-volt, 400-cps power supply.	**TYPE:** Calibrate **INTERVAL:** 120 days
TOOLS AND MATERIAL: See below.	**REFERENCES:** Sch 1900733 ATP 1900726 Wire harness 1900736
IMPORTANT: None	

TOOLS AND MATERIAL:

1. Decade resistance box, Clarostat 240C (2 required)
2. Counter, CMC 727B
3. Spectrum analyzer, HP-302A
4. Differential voltmeter, Fluke 803
5. Power supply, Trygon C36-50
6. Transformer, 1016088

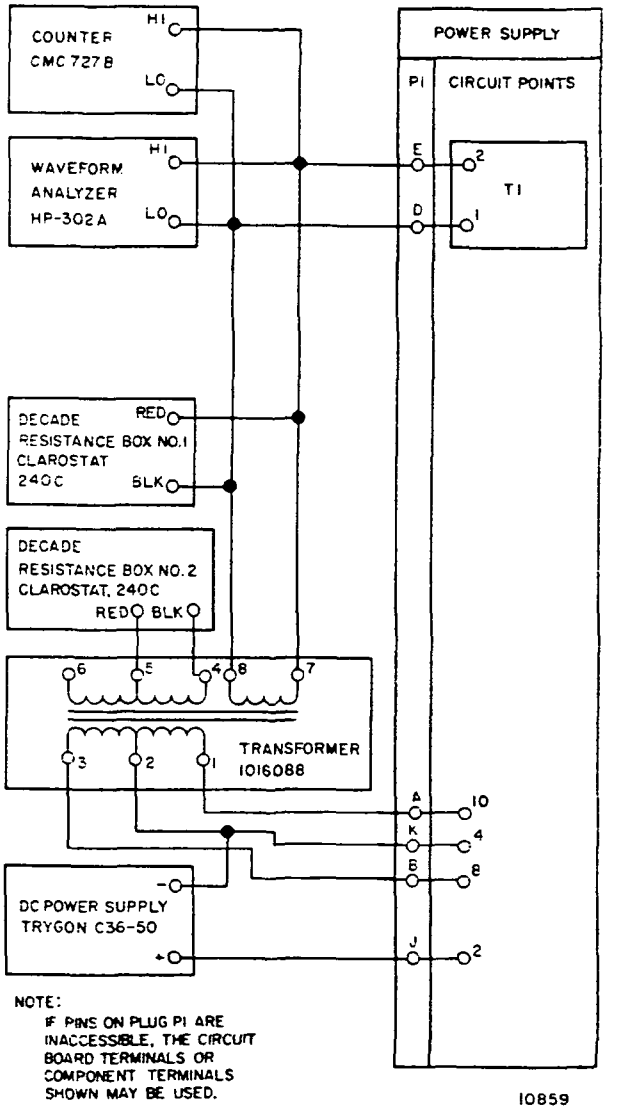
A. PREPARATION: NA

B. PROCEDURE:

CAUTION: Equipment must be turned off whenever any power connections are being made. Make decade resistance box connections using on-off switches.

1. Establish test setup as shown.

NOTE: To obtain maximum accuracy from test equipment during the following procedures, 30 minutes warmup time must be allowed.



Test Setup

CAUTION: To insure that the power supply does not overheat during this test, a small blower must be directed at the power supply heat sink.

2. Set decade resistance box no. 2 to 600 ohms.

NOTE: Use differential voltmeter to make all voltage measurements in the following procedures.

3. Set power supply output to 28 (±0.3) volts dc.
4. Set decade resistance box no. 1 to 400 ohms.
5. Measure and record ac voltage between pins 7 and 8 of transformer 1016088.
6. Adjust potentiometer R7 to obtain 115 (±0.5) volts ac between pins 7 and 8 of transformer 1016088.
7. Record frequency as indicated on counter.
8. Adjust inductor L1 to obtain frequency indication of 400 (±2) cps on counter.
9. Turn inductor L1 adjustment screw approximately seven degrees in direction opposite to last adjustment made in step 8.
10. Set decade resistance box no. 1 to 235 ohms.
11. Measure and record output voltage and frequency between pins 7 and 8 of transformer 1016088. Voltage shall be 115 (±5) volts, 400 (± 10) cps.
12. Disconnect decade resistance box no. 1.
13. Repeat step 11.
14. Reconnect decade resistance box no. 1 between pins 7 and 8 of transformer 1016088.
15. Disconnect decade resistance box no. 2.
16. Repeat step 11.
17. Disconnect decade resistance box no. 1.
18. Repeat step 11.
19. Reconnect decade resistance box no. 1 between pins 7 and 8 of transformer 1016088.
20. Reconnect decade resistance box no. 2 between pins 4 and 5 of transformer 1016088.
21. Vary dc power supply output from 27 to 29 volts.
22. Repeat step 11.
23. Set dc power supply output to 28 (±0.3) volts.
24. Distortion, as determined by spectrum analyzer, shall be less than 5 percent.
25. Disconnect decade resistance boxes no. 1 and no. 2. Distortion, as determined by spectrum analyzer, shall be less than 5 percent.
26. Dismantle test setup.

C. CALCULATIONS: NA

D. RESULTS: NA

JOB: CALIBRATION OF 2-VOLT, 3200-CPS POWER SUPPLY	**JDC** 19211 (Sheet 1 of 2)
SUBSYSTEM: OPTICS-INERTIAL ANALYZER	**ASSEMBLY:** 60 A7A2
DESCRIPTION: Procedure to check and adjust the output of 2-volt, 3200-cps power supply.	**TYPE:** Calibrate **INTERVAL:** 120 Days
TOOLS AND MATERIAL: See below.	**REFERENCES:** ATP 1900081 Sch 1900341 Wire harness 1900418
IMPORTANT: None	

TOOLS AND MATERIAL:

1. Autotransformer, General Radio W5MT3A
2. Counter, CMC 727B
3. Differential voltmeter, Fluke 803
4. Vacuum tube voltmeter, HP-400H
5. Decade resistance box, Clarostat 240C (2 required)
6. Spectrum analyzer, HP-302A

A. PREPARATION: NA

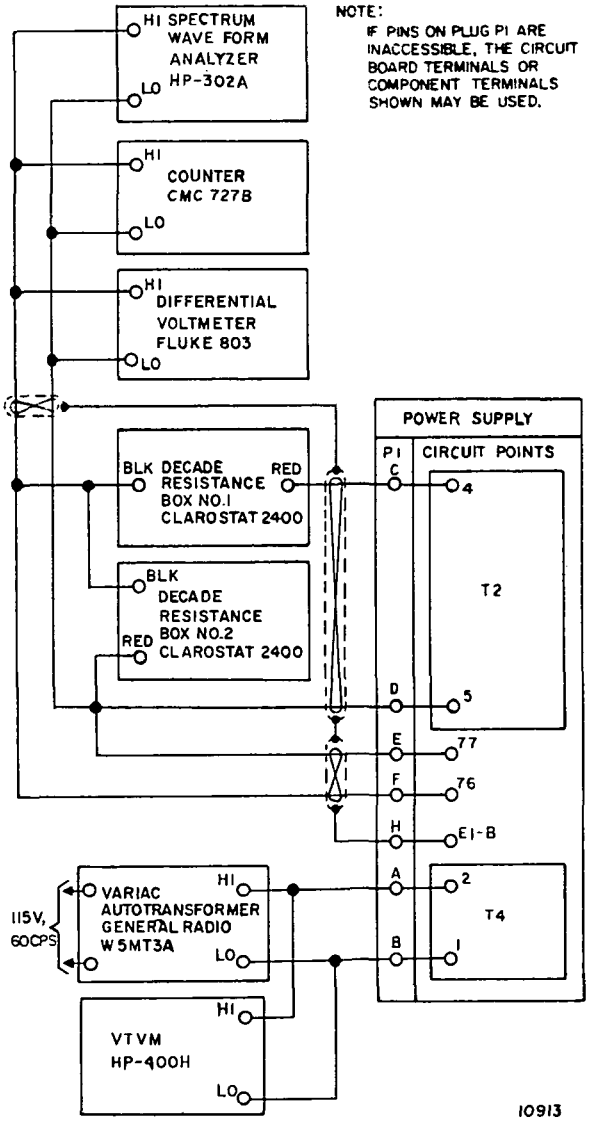
B. PROCEDURE:

CAUTION: Equipment must be turned off whenever power connections are made.

1. Establish test setup as shown.

NOTE: To obtain maximum accuracy from test equipment during the following procedures, 30 minutes warmup time must be allowed.

2. Set autotransformer to 115 (± 3) volts.
3. Set decade resistance box no. 2 to 2 ohms.



Test Setup

4. Set decade resistance box no. 1 to 2 ohms.
5. Read and record differential voltmeter indication.
6. Read and record counter indication.
7. Indication recorded in step five shall be 2 (±0.02) volts. If necessary, adjust potentiometer R21 to obtain required indication.
8. Indication recorded in step six shall be 3232 (±32) cps. If necessary, adjust inductor L1 to obtain required indication.
9. Set decade resistance box no. 1 to 4 ohms. Differential voltmeter indication shall remain at 2 (±0.2) volts. Counter indication shall remain at 3232 (±32) cps.
10. Record the percent distortion as determined by the spectrum analyzer. Distortion shall be less than 3 percent.
11. Set decade resistance box no. 1 to 2 ohms.
12. Vary autotransformer output from 105 volts to 125 volts. Differential voltmeter indication shall remain at 2 (±0.1) volts. Counter indication shall remain at 3232 (±32) cps.
13. Set autotransformer output to 115 (±3) volts.
14. Repeat step 10.
15. Dismantle test setup.

C. CALCULATIONS: NA

D. RESULTS: NA

Chapter 7

REPAIR AND REPLACEMENT

No special procedures are required to repair or replace optics-inertial test set components. The following precautions must be observed, however, during repair or replacement of optics-inertial test set components:

a. Connect all consoles to a ground line before applying power.

b. Discharge all power line filters before beginning any work.

c. Avoid coming in contact with high voltage areas. (See figures 7-1 and 7-2.) Exposed power terminals can be touched by reaching under ac power protection panel.

d. Insure that the AGE coolant and power console is firmly attached to a rigid floor at all times unless all drawers have been removed from the console.

e. Move all consoles only with a forklift truck, and only after removing all drawers.

f. Provide firm support for current source monitor panel during removal, as component does not rest on drawer slides.

g. Protect current source monitor panel from all vibrations and other sudden movements, and keep level at all times. If current source monitor panel is jarred or tilted, do not use for two days.

h. Lift AGE coolant and power console coolant supply only by flanges along top of both sides.

i. Disconnect blower cable before starting removal of any blower panel.

j. Disconnect all cables not attached to oscillograph signal selector panel retractor before unlocking dead-man lock behind panel.

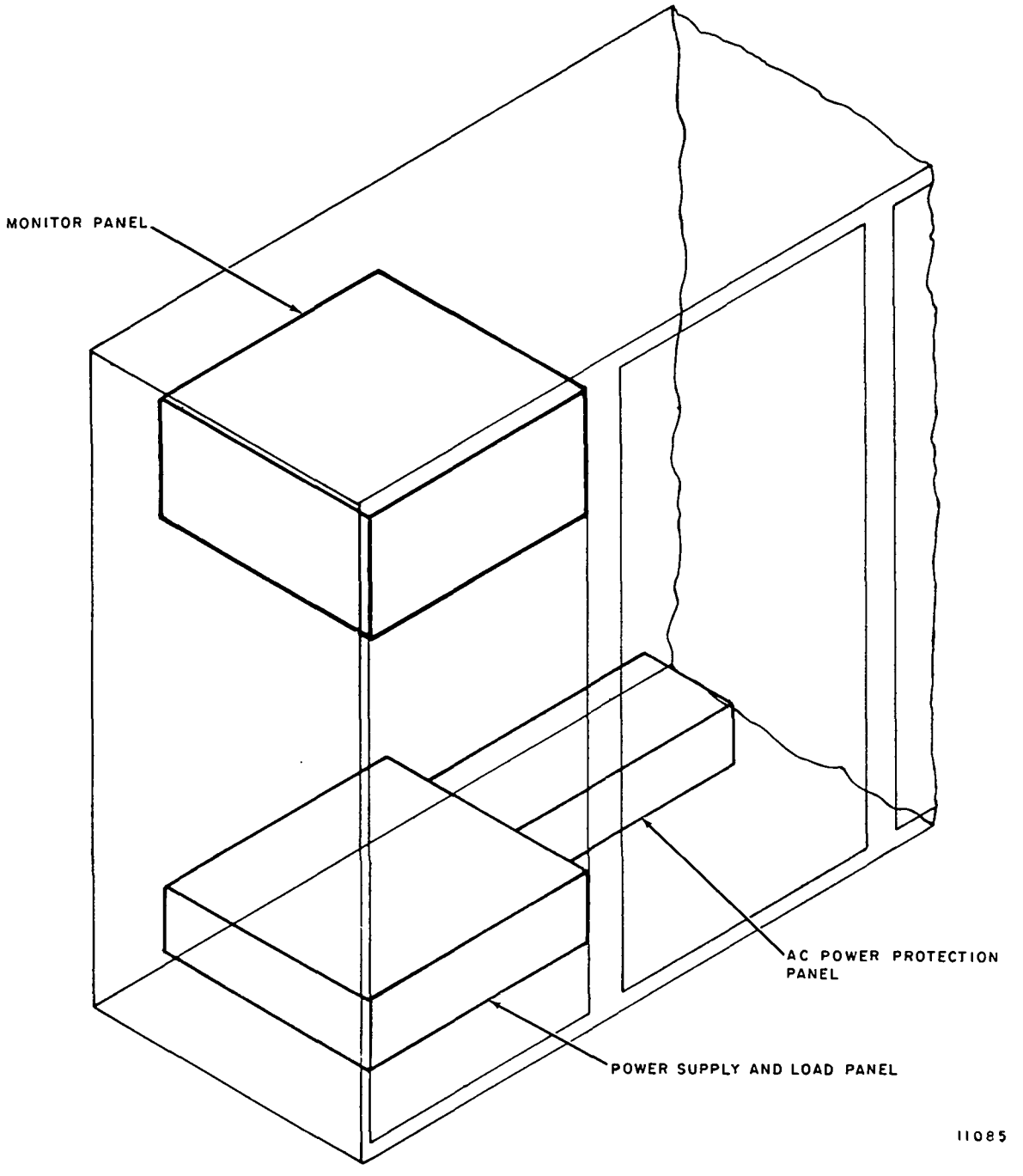


Figure 7-1. Hazardous Voltage Areas in Optics-Inertial Analyzer

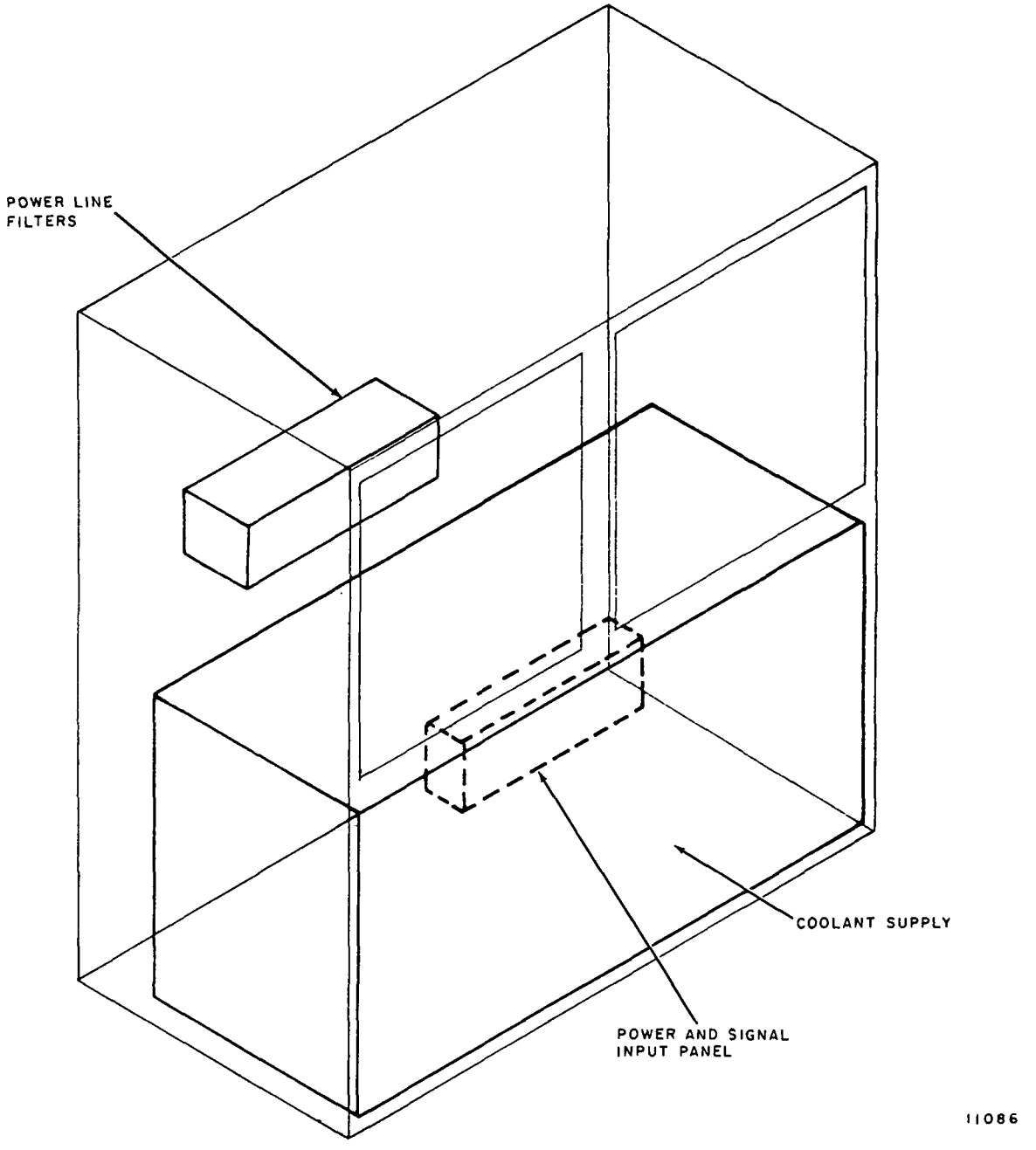


Figure 7-2. Hazardous Voltage Areas in AGE Coolant and Power Console

k. To prevent disconnected cables from falling into next lower drawer, hook cable loops onto pins located on panel retractor or on rack front.

l. Adjust tension on coolant supply retractor so that hoses are held in position but can be moved easily while pulling out coolant supply.

Appendix A

NUMERICAL LISTING OF JDC'S REFERENCED WITHIN THIS MANUAL

JDC Number	Job
19100	Calibration of monitor panel
19120	Calibration of wheel power fail and DCU motor excitation failure sensor
19121	Calibration of X, Y, and Z PIPA error sensor
19122	Calibration of IG, MG, and OG CDU error sensor
19123	Calibration of IMU, accelerometer, and CDU failure indicator sensor
19124	Calibration of IG, MG, and OG servo error sensor
19125	Calibration of 3200-cps voltage comparator
19126	Calibration of encoder excitation failure sensor
19127	Calibration of ±28-volt dc pilot power supply
19129	Test of verification assembly
19130	Calibration of 3200-cps frequency comparator
19165	Calibration of IG, MG, and OG precision alignment servo amplifier
19168	Calibration of phase sensitive error detector
19169	Calibration of gimbal dump protection assembly
19170	Calibration of gimbal position display 1-speed resolver
19171	Calibration of gimbal position display 16-speed resolver
19180	Calibration of oscillograph signal selector
19191	Calibration of buffer amplifier (phase generator)
19192	Test of buffer amplifier (800-cps, $\pi/2$-phase)
19193	Test of buffer amplifier (800-cps, 0-phase)
19194	Test of buffer amplifier (3200-cps)
19200	Test of power supply and load panel
19210	Calibration of 115-volt, 400-cps power supply
19211	Calibration of 2-volt, 3200-cps power supply
19220	Calibration of temperature monitor and control panel
19500	Packing of optics-inertial test set components